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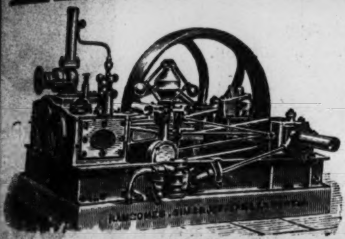

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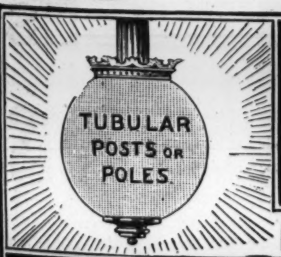

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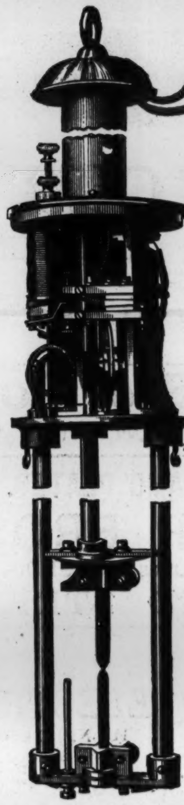

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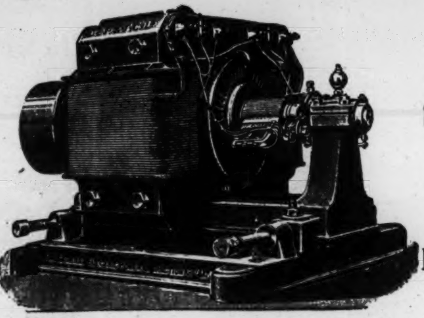

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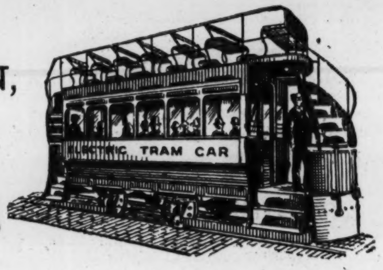

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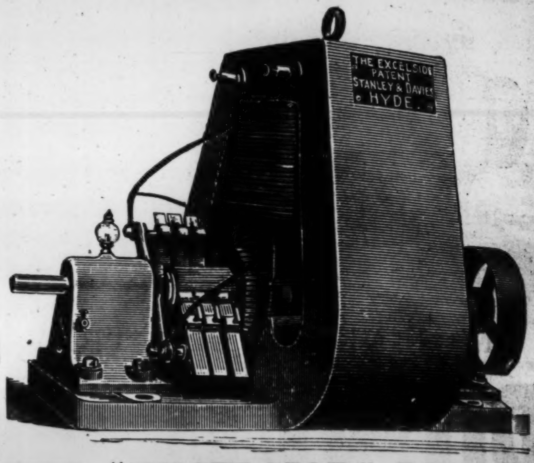

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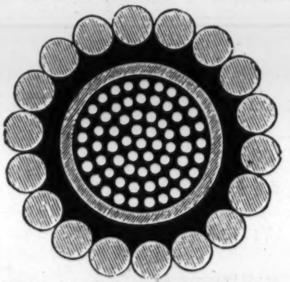

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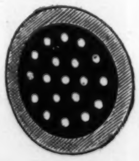

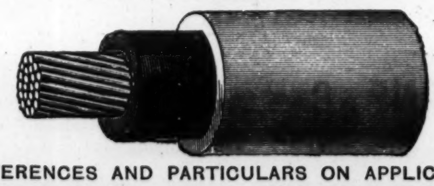

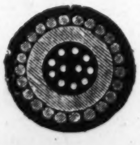

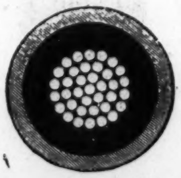

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England.

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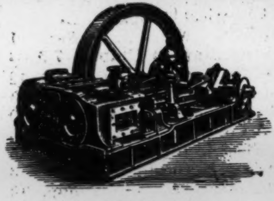

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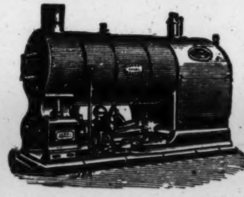

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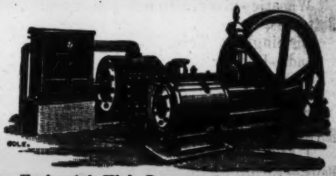

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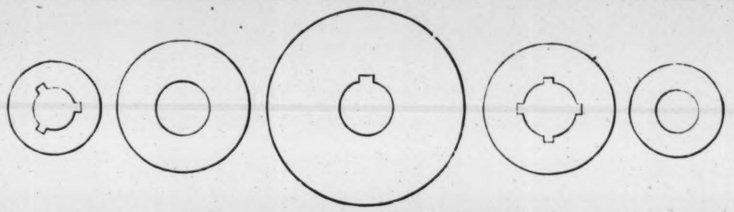

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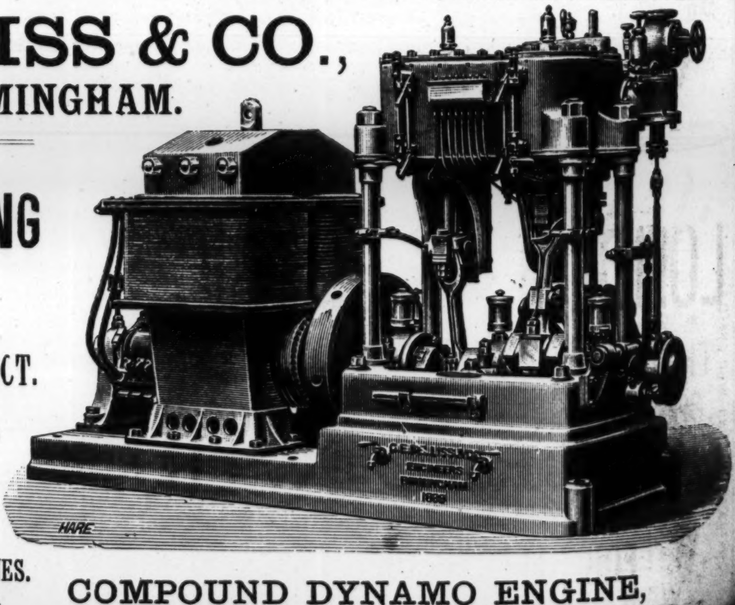

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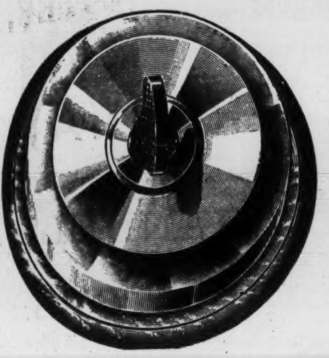

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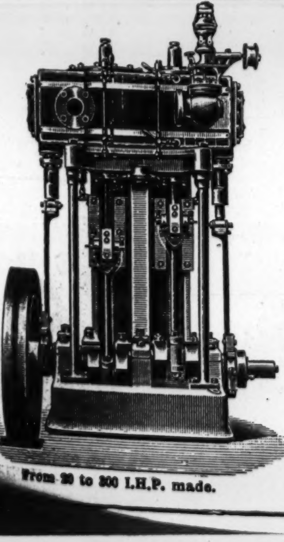

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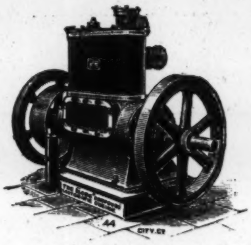

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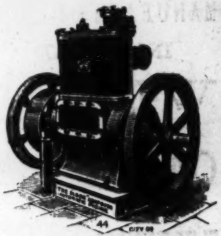

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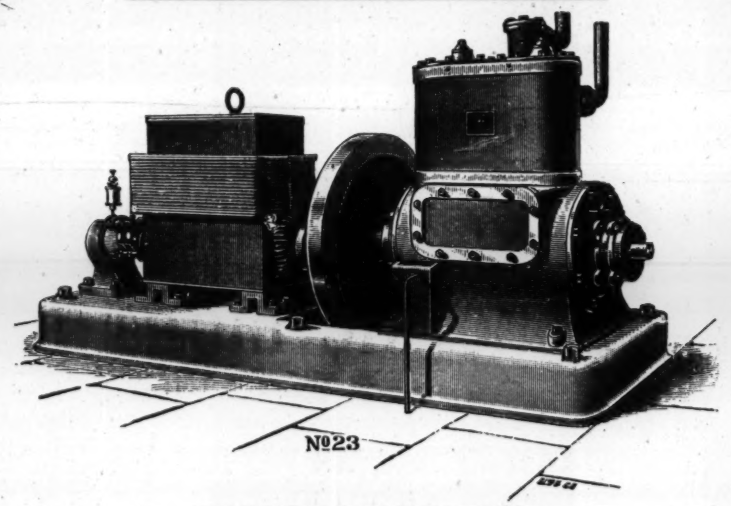

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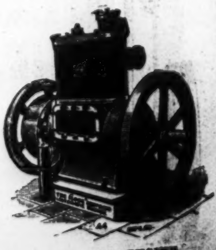

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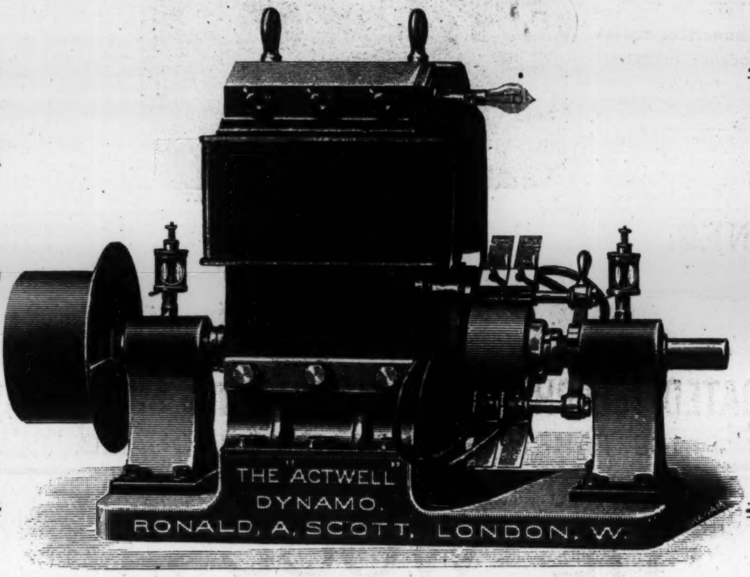
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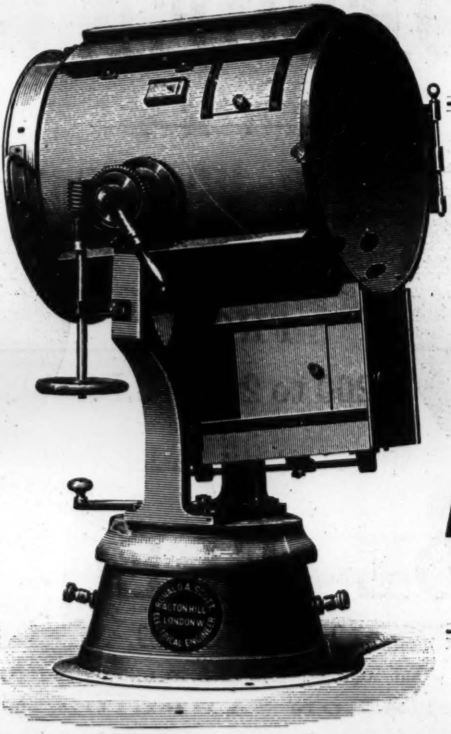

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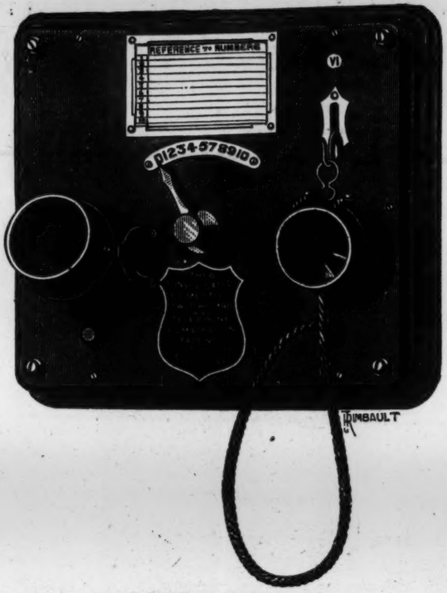

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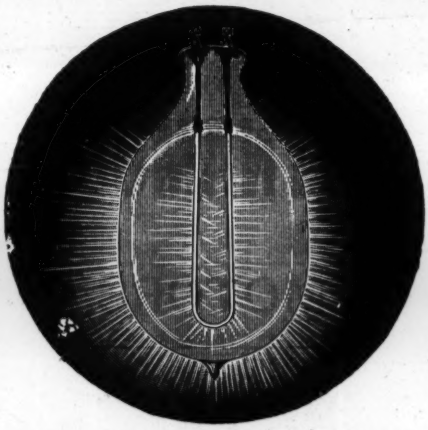

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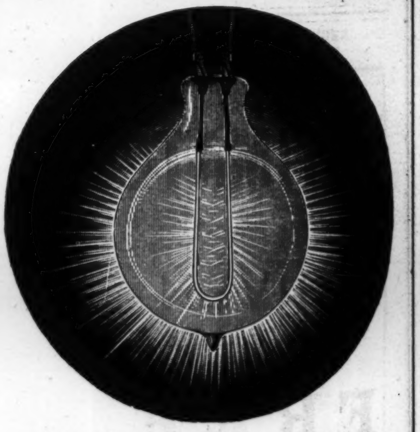

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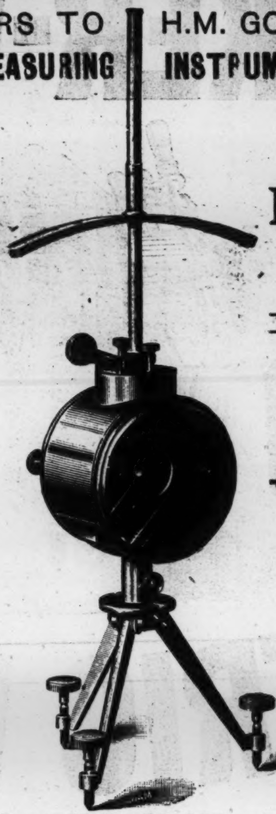

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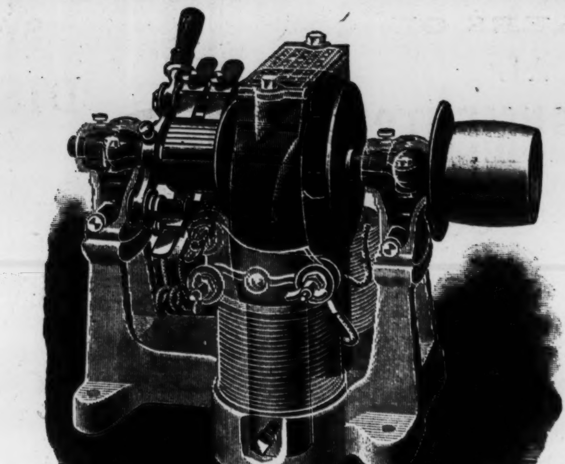

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At the factory B, a diminution of 3 per cent. of G.P. produces an increase of 600 megs.

But if we compare a G.P. coming from the factory A and a G.P. coming from factory B, having the following compositions:—

Factory A.		Factory B.	
Water	3·1	Water	3·1
Resin	35·9	Resin	35·4
Gutta	61	Gutta	61·5
	100·0		100·0

we find for one 500 megs. for the other 800 megs., being a difference equal to 60 per cent., whilst the gutta-perchas are identically the same, tests being made under exactly the same conditions by the same expert.

One cannot even suppose that there has been something left out of the analysis, since the total of 100 parts shows it to be complete.

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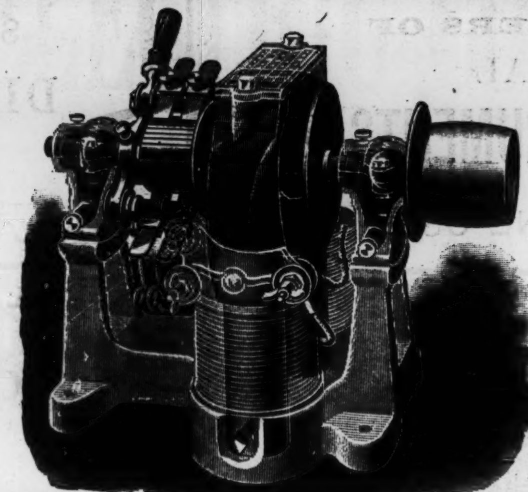

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We do not think that the article is destined to revolutionise our knowledge on gutta, and, in any case, if it does effect a revolution, we shall quickly return from our errors, and be guided by the experience of 40 years; but an article of this nature, coming from an eminent member of the French Administration, will not fail to cause lively sensations of pleasure and disgust in the respective factories, A and B.

The chemist is undoubtedly a very useful man in his place, but recognising his inability to distinguish even between gutta and rubber, it would surely have been prudent of M. Lagarde to be less dogmatic.

THE LONDON AND PARIS TELEPHONE LINE.

THE submersion of the cable which completes the telephone line between London and Paris will probably have been effected ere these pages leave the printer's hands, and next week experimental work will be carried out through the circuit prior to the opening of the line for public use. A great deal will probably be made of the fact that telephonic communication has been effected between the two capitals, though the feat, if it can be called such, is not actually one of particular magnitude, for a longer length than the one in question (telegraphically), including 28 miles of cable, has been for some time in operation in South America with success. Great care has, however, been exercised in the case of the London-Paris line to make the conditions for working as favourable as posssible, and the cable and aerial wires have been specially designed for the purpose; the margin allowed within the breakdown point of good speaking is large, the "K R" being a little over 5,000, as compared with 10,000, the limiting value; there is little fear, therefore, but that excellent speech will be attained. As regards the financial value of the line, it is extremely difficult to give a forecast; opinions differ, we believe, considerably on the point. Many express the belief that the opening of the line will be speedily followed by the construction of others of a like nature, rendered necessary for the large traffic which will pass over the wires. Personally we are not sanguine that such will be the case, and we imagine that the enthusiasm on the subject is more marked on the French than on the English side of the Channel. However, the whole experiment will not be a costly or risky one, for should it be found that the traffic is not after all of a heavy nature the wires would of course be available for ordinary telegraphic communication; and we believe that an extra link or two of this kind would not be a mere luxury, for the steady increase in telegraphic work across the Channel must eventually necessitate additional means of communication.

The Electric Transmission of Power.

IN his second Cantor lecture, Mr. Kapp gave some historical references to electromagnetic induction, from the discoveries of Oersted to the evolution of the dynamo machine. Among several interesting experiments was one in which the brushes of two electric motors were connected by means of conducting wires. No current was sent through the armatures, but the field-magnets of each motor were separately excited. Immediately the armature of one motor was moved through a small angle, a corresponding angular displacement was observable in the armature of the other motor, illustrating in a simple, but very effective manner the electric transmission of power. The slightest motion of the generating armature produced sufficient current to overcome the inertia of the armature in a distant receiver, which simultaneously rocked to-and-fro, giving the system the appearance of motion between mechanically connected bodies. The E.M.F. generated in a given armature can be calculated by means of Kapp's formula. Without much introduction, and without mentioning the existence of ring armatures, the lecturer went on to describe the various methods of winding drum armatures. Table II. (see p. 315) is intended to show how the wires are laid on in succession, and how the potential increases from wire to wire in the case of an 8-pole dynamo. The letters F and B refer to the front and back of the armature core, and letters D and U denote "down" or "up," as the conductors are carried round the ends of the core. In text books it is usual to illustrate the methods of winding by means of diagrams showing only a few conductors, and the present table is intended to convey the idea of the adding up of the E.M.F. produced in the adjacent wires or coils on an armature.

Relation of Speed and Power in Transmission Plants.

In the case of series motors driven by series dynamos, automatic regulation can only be obtained within certain limits, as was shown by the aid of characteristic curves, at the lower portions of which "racing" of the machines would take place after a sudden and considerable reduction of the load. Where constant speed is requisite with greatly varying loads, shunt machines must be employed, which at a constant potential maintain a constant field, and thus effectually prevent racing; this Mr. Kapp demonstrated experimentally. It is, however, necessary that the field magnets be of wrought iron, and that the machines are never worked up to their full load, in order that they may respond readily to sudden changes in the load. For locomotive purposes, on the other hand, it is necessary to have variable speeds, and then it is usual either to insert artificial resistances between the switch and motor, aud thus waste a portion of the energy, or to arrange, as is done in Mr. Reckenzaun's system, that the resistances of the field magnet coils themselves can be varied, and thus have no idle wire, and yet get a variable field. The novel self-regulating device for electric transmission plants, introduced by the Allgemeine Elektricitäts Gesellschaft, and mentioned by Mr Kapp on Monday last week, we described on page 115 of our issue, dated January 23rd. So much time was taken up by experiments that the latter and most important part of the second lecture relating to the best section of conductors, and the cost of plant and working expenses, had to be left over, and the audience had to be contented with a study at home of Tables III. and IV.; the latter gives the cost of existing plants operating in various countries.

Examples of Electric Power Transmission.

THE third and final of the Cantor lectures on the electric transmission of power was delivered on Monday last at the Society of Arts. It was full of interesting facts, and it may be regarded as the most valuable of the series. Mr. Kapp opened his discourse by referring to certain rules laid down by Sir William Thomson, and by Professors Ayrton and Perry for calculating the best size of conductors, and it was shown that neither of these methods was universally applicable. Professors Ayrton and Perry's paper, read at the Institution of Electrical Engineers, in 1888, started with the assumption that the current has a constant value, whilst Sir William Thomson's rule ignores the voltage. Table III. was prepared by the lecturer, and it contains all the functions entering into any system of electric transmission, and Table

IV. gives the cost of transmission plants in actual operation. After paying a well deserved tribute to Mr. Brown, of Oerlikon, for his liberality in supplying full information on the subject, Mr. Kapp described the installation at Schaffhausen, which provides the Spinning Mills Company with electric power, and incidentally an interesting comparison was made between rope transmission, hitherto so much used in Switzerland, and electric transmission. It is satisfactory to note that electricity is rapidly replacing the teledynamic methods, for the following main reasons: the maximum power, which can be transmitted by a single rope, is 330 H.P.; whereas, with electricity there is no such limit; ropes wear out, electric cables scarcely deteriorate; the pulleys over which the rope is carried require attention and involve costly charges; finally climatic influences, wet and dry, interfere with the efficient working of ropes. The generating station at Schaffhausen contains five 350 H.P. turbines, of which only two are used at present. Motion is transmitted from the turbines to the dynamos by means of ropes. The dynamos have six poles and generate 330 ampères at 624 volts. There are four cables of ·437 square inch section to transmit the electric current to the mills, 750 yards distant. Great care has been exercised in the insulation on the poles, and provision against damage through lightning has been made, firstly, by connecting the steel wire rope which runs over the the tops of the poles, to earth, and secondly, by the employment of four lightning arresters at each station. The dynamos, which are "over-compounded," run at 300 revolutions per minute. With the full current flowing through the line the loss of potential is 24 volts at the extreme end. In order to start the motors gradually, without resorting to cumbersome resistance coils, Mr. Brown has devised an ingenious method of cross-coupling of wires in the machines, but it would be difficult to describe this without diagrams. The commercial efficiency of the plant is 78 per cent.; the variation of speed with extreme loads, 3 per cent.; its entire cost was £6,800; and the company at Schaffhausen charges £13 12s. per H.P. delivered per annum, which is considerably less than steam power in the district.

Electric Transmission at Niagara Falls.

THE largest of existing plants will soon be eclipsed by the projected scheme of converting a 25,000 H.P. waterfall, a minute fraction of one of the Niagara falls, into electric energy and transmitting it to a place of application 20 miles distant. The commission charged with this project invited tenders in all parts of the world, and among 20 competitors, 14 complied with the conditions stipulated. Eight of these competitors tendered for both the generating plant and the transmission plant; four offered to supply generating machinery only, and two tendered for methods of transmission. Among the mixed systems of transmission there were seven electrical, six pneumatic, and two hydraulic. Electrical engineers, said Mr. Kapp, are hardly prepared as yet, to undertake such gigantic work at the present day, but the time was near at hand when there will be no limit to the dimensions of electric transmission plants; it is merely a question of voltage, and that can be solved by means of transformers.

Limit of Distance in Electric Transmission.

IN Table IV. none of the installations cover a greater distance than 6¼ miles. The limit of distance depends upon the E.M.F. admissible. In the case of continuous current plants the voltage is limited in a twofold degree; firstly, by the commutator, and secondly, by the insulation of the dynamo and motor wires. A single commutator cannot be depended upon to stand 3,000 volts for any length of time, nor can the best wire covering on the armature stand a greater tension. The placing of several machines in series again presents serious difficulties; therefore, in the event of power being transmitted in large quantities at high tension, alternating current machines and transformers will have to be resorted to. The alternators will be made to give a moderate E.M.F., which can be transformed up. The difficulty of commutators being eliminated, it is only a question of obtaining sufficient insulation in the transformers, and this has been attained by surrounding the entire coils with an insulating oil. Mr. Kapp has tested such a transformer with potentials of from 2,500 to 17,000 volts continuously for several days. Mr. Brown has gone as far as 36,000 volts without breaking down the insulation. At the receiving end the current will be transformed into low tension for working the motors.

Alternating Current Motors.

FOR several years past, from the days of Prof. Ferrari's investigations, which were followed by those of Tesla, Zipernowsky, and a host of imitators, we have periodically heard of the question of alternating current motors being solved. More than once have we questioned the solution of this difficult problem, and certain enthusiastic inventors had the free use of our pages for the ventilation of their pet theories, yet we are not aware of the existence of any commercially successful motor, one which gives a good efficiency with a reasonable speed at variable loads, and which is entirely self-starting. If those gentlemen, who then contradicted our assertions, can now show us any radical improvements, we shall be glad to record them. Mr. Kapp spoke of several types of small alternating current motors with two and three wires, but he has not pointed out any successful applications. We were particularly struck with Mr. Kapp's ingenious model for illustrating the theory of rotation by alternating currents. This model consisted of two cranks capable of revolving simultaneously two connecting rods and a disc movable on its centre. The centres of the cranks and the centre of the upper junction of the connecting rods formed a triangle. The pin through the eyes of the connecting rods represented a "phantom magnet" influencing the motion of the disc. By varying the relative angle between the cranks, the pin (phantom magnet) described straight lines, circles, or ellipses, dragging with it the disc which revolved with more or less regularity according as there was any slip, such slip indicating loss of energy. We had to imagine that the crank angles corresponded to the position of the wire coils on the armature relatively to each other.

Electric Machine Tools.

AMONG practical examples on electric transmission to short distances, Mr. Kapp pointed out several useful tools in use at Messrs. Denny Brother's shipyard, Dumbarton, and he showed in operation a tube cutting machine and a drilling machine, worked by continuous currents obtainable from the Society of Arts installation. The drilling machine is provided with its own holding on magnets so that it can be swung over the side of a ship, or a boiler, and stick to it as long as required without any clamping or fixing. The convenience of such a machine is very great, a considerable saving in time and labour resulting from its use. Electric motors have been applied with perfect success to boring tackles for stern tubes, furnace flues and a variety of engineering purposes with decided economy. Some of the electric mining machines recently described at the Institution of Civil Engineers were also exhibited at the Society of Arts, and we have no doubt that the audience went away fully convinced of the enormous capabilities of electric motors for industrial purposes. Mr. Kapp wisely emphasized the fact that whilst electricity will not rival steam, it is nevertheless, an excellent medium for the utilisation of waterpower at a distance, for the propulsion of tramcars, for underground railways, and for numerous tools and appliances in everyday life.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM OUR OWN CORRESPONDENT.]

THE shares of the General Electricity Company, recently constituted in Vienna, are now introduced into the market by the Anglo-Austrian Bank, and the public is invited to subscription in a prospectus giving some interesting data on the previous working of the electric establishment in the Neubadgasse, Vienna, which the company in question has taken over from the firm of Siemens and Halske.

The operations of this establishment were commenced in September, 1889, with lighting up the German People's Theatre, with a capacity of 2,195 glow-lamps at 16 normal candles each. In October, 1889, further installations were added, and the number of lamps rose to 2,700, in November to 3,850, and in December to 4,700. The monthly returns during 1890 are as follows:—January 6,070, February 6,450, March 7,080, April 7,640, May 7,800, June 8,040, July 8,220, August 8,540, September 9,400, October 10,500, November 11,470, and December 12,580. The present number is about 13,300. To meet the constantly-growing demand, a fourth steam engine, two boilers, and a system of accumulators have been procured.

According to the conspectus, on the working receipts and outlay for the year 1890, submitted by Messrs. Siemens and Halske, on an average capital of 1,440,000 florins.

In the First Half of 1890.

	Florins.
Total receipts	88,044
Total expenditure	46,437
Or a surplus of	41,606

In the Second Half of 1890.

	Florins.
Receipts	139,447
Expenditure	68,917
Surplus	70,530

The expenditure does not include the depreciation of buildings and machinery, and the net profit is accordingly so much smaller than the surplus shown.

The shares of the nominal value are offered at 225, and on February 23rd they were being dealt in on the Vienna Stock Exchange at 231 florins.

The erection of electrical works at Budapest, which is eagerly demanded by the public, is now being diligently considered by the metropolitan magistracy. The municipality has accepted the last proposals of the gas company prolonging the gas agreement to the year 1910, in return for which the company renounces its right of priority as against other methods of lighting. The city has now consequently the right to grant concessions for the erection of electrical works, and a resolution has already been concluded by the municipal representatives which empowers, or, in fact, instructs the magistracy, to take without delay steps for the prompt introduction of the electric light in Budapest. Applications for concessions were handed in some time ago, among others one from the International Electricity Company of Vienna, which undertakes to erect alternating current works outside of the inhabited districts capable of supplying all the wards of Budapest and the suburbs. How urgently the want of the electric light is felt is proved by the circumstance that a memorial has been addressed to the authorities by a number of influential citizens praying that the application of the International Electrical Company of Vienna be at once examined on its merits, and quickly decided on, so that it may be possible to supply the city with electric light next winter. Messrs. Ganz & Co. have joined in this application, and the intention is subsequently to convert the works into an independent Hungarian undertaking.

The electric lighting of the Royal Hungarian Palace at Ofen has been finally agreed on, and the firm Ganz & Co. are entrusted with its execution. Operations are to begin in the month of March, immediately after the departure of the Court, which is at present staying here. The installation will be connected with the works to be erected in Budapest, and if the latter is not ready and in action by next winter, the Royal Palace will be provisionally supplied with light by a cable from the works of Ganz & Co.

As we learn, the Popp Compressed Air Company is again aiming at the erection of electrical works in Budapest. Victor Popp has addressed a letter to the authorities, with the request that his scheme for supplying the community with compressed air and electric energy may be taken into consideration.

From the recent report on the activity of the electric department of the firm Ganz & Co. for the year 1890, we gather the following facts:—

This department has during the year just expired carried out 136 electric lighting installations, with a total of 188 arc lights and 60,500 glow lamps, from 29 central stations on their system of alternating current transformers. Of these central stations there are in Hungary, 2; Austria, 4; Italy, 6; France, 5; Spain, 3; Russia, 2; Switzerland, 2; Sweden, 1; Brazil, 3; Australia, 1. The firm has also carried out several electric installations in India. It has also arranged the electric lighting of the Imperial Russian domains at Zarskoje Selc, and the Palaces of the Grand Princes Alexis and Michael.

It must also be mentioned that the Hungarian Minister of Commerce has rejected the petition for the concession of an electric railway between Vienna and Budapest.

SOME EXPERIMENTS ON GUTTA-PERCHA.

THE *Annales Télégraphiques* for January—February, 1891, contains an article written by M. Lagarde, an important functionary of the French Telegraph Department, on certain experiments he carried out with the view of determining the influence exercised upon gutta-percha as an electrical insulator by the respective constituents of that material.

The gutta-perchas experimented upon were such as were met with by the author when testing cables, but although numerous samples were tested, only a few gave results which could be considered as fairly conclusive.

The elements of gutta-percha are given as—

Pure gutta	$(C^{20} H^{32})$
Fluvial resin	$(C^{20} H^{32} O)$
Albain resin	$(C^{20} H^{32} O^{2})$

with about ½ per cent. of mineral substances.

Some stress is laid upon the fibrous structure, M. Lagarde stating that the better qualities are the most fibrous, and that this characteristic affords skilled observers a valuable method of determining the quality of a specimen.

The methods adopted by M. Lagarde for separating the various elements were as follows:—

To evaporate the water the gutta was heated to 110° C. in a current of carbonic acid gas, the quantity of water being ascertained by the difference of weight.

The resins were separated from the percha by treatment in pure alcohol at boiling temperature.

The following table gives the results of three series of tests taken on gutta-percha coming from three different works; in each of the series the percha came from the same manufactory, and was used as the core for cables similar to one another, and a comparison is thus obtained between the two experiments in each series:—

SERIES A.

(1.)	Water ...	2·5	Insulation ...	$1,600^{\Omega}$
	Resins ...	44·0	Capacity ...	0 φ ·180
	Pure gutta ...	53·5		
(2.)	Water ...	3·1	Insulation ...	500^{Ω}
	Resins ...	35·9	Capacity ...	0 φ ·190
	Pure gutta ...	61·0		

SERIES B.

(3.)	Water ...	3·1	Insulation ...	800^{Ω}
	Resins ...	35·4	Capacity ...	0 φ ·180
	Pure gutta ...	61·5		
(4.)	Water ...	3·1	Insulation ...	$1,400^{\Omega}$
	Resins ...	38·3	Capacity ...	0 φ ·169
	Pure gutta ...	58·6		

SERIES C.

(5.)	Water ...	6·1	Insulation ...	$1,000^{\Omega}$
	Resins ...	35·1	Capacity ...	0 ϕ·190
	Pure gutta ...	58·8		
(6.)	Water ...	6·0	Insulation ...	600^{Ω}
	Resins ...	31·7	Capacity ...	0 ϕ·195
	Pure gutta ...	62·3		

M. Lagarde, from the above results, comes to the conclusion that the more pure gutta and less resins contained in gutta-percha, that is to say the better it is, the less it insulates, and consequently in purchasing cables insulated with gutta-percha, a maximum, as well as minimum, insulation should be stipulated.

The author then proceeds to deal with the influence the water contained in gutta-percha has upon the insulation. The following experiments are given :—

SERIES D.

(1.)	Water	6·1	Insulation ...	$1,000^{\Omega}$
	Resins	35·1	Capacity ...	0 ϕ·190
	Pure Gutta ...	58·8		
(2.)	Water	1·1	Insulation ...	$1,300^{\Omega}$
	Resins	38·2	Capacity ...	0 ϕ·180
	Pure Gutta ...	60·7		

SERIES E.

(3.)	Water	6·5	Insulation ...	$1,050^{\Omega}$
	Resins	35·1	Capacity ...	0 ϕ·100
	Pure Gutta ...	58·4		
(4.)	Water	5·4	Insulation ...	$1,400^{\Omega}$
	Resins	32·8	Capacity ...	0 ϕ·210
	Pure Gutta ...	61·8		

NOTE.—The tests in all five series were made on gutta percha core, after immersion for 24 hours in water at 75° Fhr.

The ratios of pure gutta to resins are No. 1, 1·67 : No. 2, 1·60 : No. 3, 1·66 ; No. 4, 1·88. It will be seen that the insulation of Nos. 1 and 2 should be nearly alike, but No. 2 has a higher insulation owing to its containing less water. No. 3 ought to have a higher insulation than No. 4, since it contains more resin and less gutta, but it has a lower insulation owing to the greater quantity of water contained.

M. Lagarde believes that the water contained in gutta percha assists towards its transformation into resins. Taking two specimens of gutta percha, he cut each in half, leaving one portion of each exposed to the air, while the other he placed in water. The specimens were analysed from time to time, and the following table gives the results :—

Original constituents.				Constituents after 2 months.			
			Ratio of pure gutta to resins.	In air.		In water.	
					Ratio of gutta to resins.		Ratio of gutta to resins.
Specimen No. 1.	Water ...	3·1	2·23	1·0	2·0	4·0	2·02
	Resins ...	30·0		32·5		31·8	
	Pure gtta.	66·9		66·5		64·2	
Specimen No. 2.	Water ...	9·1	2·31	4·0	1·8	10·0	1·6
	Resin ...	27·5		34·5		36·5	
	Pure gtta.	63·5		61·5		53·5	

It will be observed that the specimens kept in air lose some of the water and gutta, increasing the quantity of resins ; those left in water absorb a small quantity of it, while the gutta decreases and the resins augment ; and it will be further noticed that this decrease in gutta and increase in resins is more marked in the specimen which originally contained most water.

M. Lagarde considers that the amount of water contained in the gutta-percha used for the insulation of a cable should be restricted ; he states that it is quite easy to obtain percha which contains no more than 5 per cent. of water, and this is the maximum figure which should be adopted.

The author gives some further experiments, which he looks upon as confirming his views. A piece of core intended for a telephone cable was tested after 24 hours' immersion in water, at a temperature of 75° Fah. ; it was then removed from the water and kept dry for a month, then replaced in water at 75° Fah., immersed for 24 hours, and again tested. This course was again repeated, with the following results, an analysis being made from a piece cut off the core upon each occasion of testing :—

	April.	May.	June.
Insulation	384^{Ω}	491^{Ω}	502^{Ω}
Capacity ...	0^{ϕ}·161	0^{ϕ}·161	0^{ϕ}·161.
Water ...	4·2	2·4	1·8
Resins ...	29·8	33·4	34·1
Pure Gutta	66·0	64·2	64·1

A series of experiments is then given, which seem to have no other object than to prove that the higher the temperature the lower the insulation, that good gutta-percha kept in water increases in insulation as it ages, that some gutta-percha does not improve, and that samples of gutta-percha, coming from the same works, and subject to the same treatment in manufacture, vary in their insulation in different proportions in each specimen.

M. Lagarde, in summing up the results of his experiments, comes to the conclusion that in contracts for the manufacture of cables chemical analysis should be included. The ratio between the pure gutta and the resins should be stipulated, as also the maximum quantity of water contained in the gutta-percha. He suggests that no more than ½ per cent. of mineral substances and 5 per cent. of water should be allowed, and he would qualify gutta-percha as fair when it contained 50 per cent. of pure gutta, as good with 60 per cent., and as very good with 65 per cent.

WHAT AN ELECTRICAL ENGINEER SHOULD BE.*

By FRANCIS B. CROCKER.

IT has often been stated on high authority, such as of that Sir William Thomson and Prof. W. E. Ayrton, that the electrical engineer should be largely a mechanical engineer, the proportions usually given being "nine-tenths mechanical and one-tenth electrical." This statement is frequently repeated and has been generally, if not universally accepted. The causes which have operated to produce this opinion are, first, the fact that the extraordinarily rapid development of electric light and power has prevented even reasonable care being given to the design and construction of electrical machinery, and second, the work has generally been in charge of men entirely ignorant and incompetent, or at best, of men who had received their preparation in telegraph offices or physical laboratories where strong mechanical construction is given comparatively little attention.

In the first stages of the development of any branch of industry, the men attracted to it are apt to be either amateurs, inexperienced boys, or worse yet, quacks or men who have been unsuccessful in other lines of work.

As soon, however, as sufficient time has elapsed for men to become well prepared by education or experience and the industry becomes legitimised and attracts to it a higher order of talent, then the necessary elements to give the best results will be present and a proper relation and balance will exist between them.

I consider that this now is, or very soon will be, the condition of electrical engineering, and I contend that the electrical engineer must be an *electrical specialist* and that mechanical engineering, though a necessary part of his preparation, is nevertheless merely incidental.

The simple, and what seems to me, a more than sufficient reason for this opinion is the fact that the purely electrical part of electrical engineering is being so very rapidly and extensively developed that no one person can possibly keep up thoroughly with electrical progress in its numerous branches even at the present day and no man busy in electrical work can spare the time to read even the more important electrical journals and books. In fact it now seems to be necessary for one to become a specialist in some particular branch of electrical work in order to be successful. Such being the case, it certainly is impossible for the general electrical engineer to give more than a small fraction, say one-quarter, of his time to mechanical engineering instead of the nine-tenths heretofore recommended. This is not because mechanical engineering is not of the greatest interest and importance in itself, but because a man's time and abilities are limited and *electricity* is a gigantic subject, a small part of which is probably all one human mind can master.

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* New York *Electrical Engineer*.

In order not to be misunderstood, I will state that I thoroughly realise that mechanical engineering is, and probably always will be, an essential *part* of the electrical engineer's knowledge, just as chemistry is essential to an understanding of electro-metallurgy, primary and secondary batteries, &c., but only as a preparation.

In any case the electrical engineer should be an *engineer* in the broadest and best sense, his profession being analogous to, but not identical with, that of the civil, mechanical, and mining engineers.

In conclusion, I would call attention to the fact that the mechanical weakness which arose in the early development of the dynamo and motor has now nearly passed away, and to-day the standard types of dynamo and motor are probably as well made mechanically as any other class of commercial apparatus. Moreover electrical machinery is usually remarkably simple, mechanically. Compare the number of working parts of a 50 H.P. motor with those of a corresponding steam engine and there will be found in the former about one-fifth as many oil cups, bearings, pivots, sliding surfaces, &c.

On the other hand what is needed in the dynamo and motor to-day is improvement in the armature, commutator and brushes, and in means for avoiding sparking, burning out, &c., all of which belong to the *electrical* part of the machine and involve very difficult electrical questions. Of course first-class mechanical construction is necessary even in these parts but only as incidental to the carrying out of correct electrical principles.

In the design of a street car electric motor, which is peculiarly mechanical, although the electrical difficulties encountered have been fully as great as the mechanical, I believe that a mechanical engineering specialist should be employed just as an architect should always be called in to design a house or a plumber to put in water pipes.

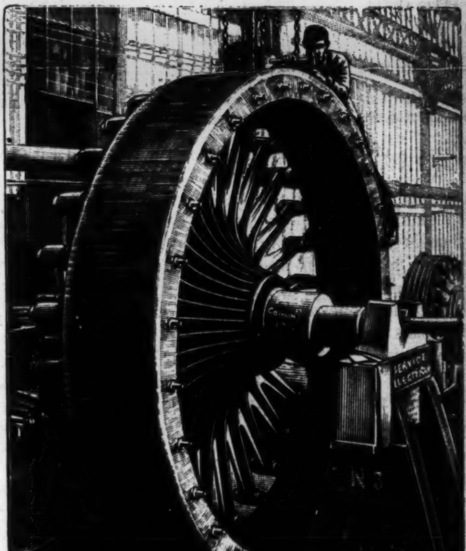
THE ELECTRICAL SECTOR OF THE PLACE CLICHY, PARIS.

THE distribution of electrical energy over an extensive area, writes M. Hospitalier in *La Nature*, involves either the indefinite multiplication of the number of stations or the employment of high tensions, if we would avoid expensive systems of canalisation. The success of distributions by alternating currents and transformers depends on the facility with which these high tensions can be produced and transformed into low tensions in order to be utilised. Unfortunately, alternating currents involve serious dangers, and, from their very nature, are ill-adapted to applications of motive power, and cannot be employed at all for electro-chemical operations. If to these objections we add the impossibility of storing up energy distributed under the form of alternating currents, we can easily understand why, in the greater number of cases, electricians should hesitate to use these currents, and why so many attempts are made to effect distributions by means of the continuous current, if not at a high tension, at least at an average tension, in order to retain both the advantages of high tensions from an economical point of view and the facilities of employment and storage offered by the continuous current. Among the numerous systems of distribution having regard to these facts, either proposed or realised during the last few years, that adopted by the company of the section of the Place Clichy is worth describing somewhat in detail, for it shows once again the varied, and we may say, inexhaustible resources which the electrician has at his disposal for the solution of problems that are apparently most complicated. The problem solved in this case is the following :—

Given a general system of canalisation supplied by dynamos maintaining between the two conductors of the canalisation a difference of potential of 440 volts, to divide this difference of potential into four equal parts of 110 volts each, on which it will be possible to establish utilising apparatus that can be varied at will either in number or in power, without affecting the working of the other apparatus connected with the system.

It is, moreover, possible to connect apparatus working at differences of potential higher than 110 volts, and thus to obtain a distribution at several potentials, although the central station may only furnish one. This advantage will be highly appreciated when we have to establish motors of a mechanical power exceeding 10 kilowatts. These can then be installed on a difference of potential of 220 volts, electrical tramways with overhead or underground conductors being on the contrary supplied by the total difference of potential of 440 volts, economy always being kept in view throughout the system by employing, in each case, the highest potentials compatible with the good working of the receivers or other apparatus used. In order to understand the economy of this arrangement, we must examine in turn the central station, the canalisation, the distribution and the regulating apparatus.

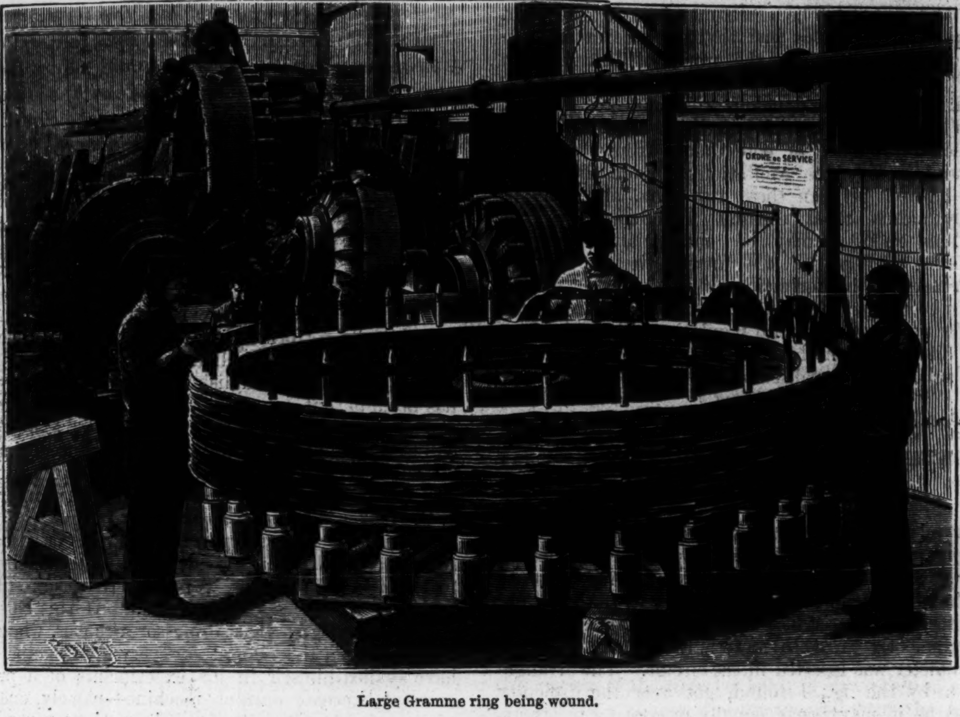
Central Station.—The central station established in the Rue des Dames, at Batignolles, in a splendid building erected for the purpose, comprises a series of tubular boilers, producing steam at a pressure of from 6 to 7 kilogrammes per square centimetre. This steam supplies three horizontal steam engines, of the Corliss type, each driving a large dynamo and three Armington and Sims engines of less power, each working two smaller dynamos. The only fact worth mentioning from a mechanical point of view, is the intended and pre-arranged absence of condensation, notwithstanding the power to be produced, which exceeds 2,000 steam horse-power when all the machines are working. The economy of fuel effected by means of condensation in an installation on this scale is of little importance as compared with the increased simplicity and safety of working gained by its suppression. Each of these steam engines of 600 H.P. turns at an angular speed of 65 revolutions per minute and works directly a continuous current multipolar dynamo producing 700 ampères and 450 to 500 volts, or 350 kilowatts. These are the most powerful continuous current dynamos at 500 volts that have yet been made. The armature is a Gramme ring 3·3 metres in diameter and 58 centimetres in thickness, with eight fixed inner poles. This ring is mounted on a projecting star of 80 rays. It consists of a number of sheets of iron supported on



Construction of the Gramme ring armature, 3·3 metres in diameter.

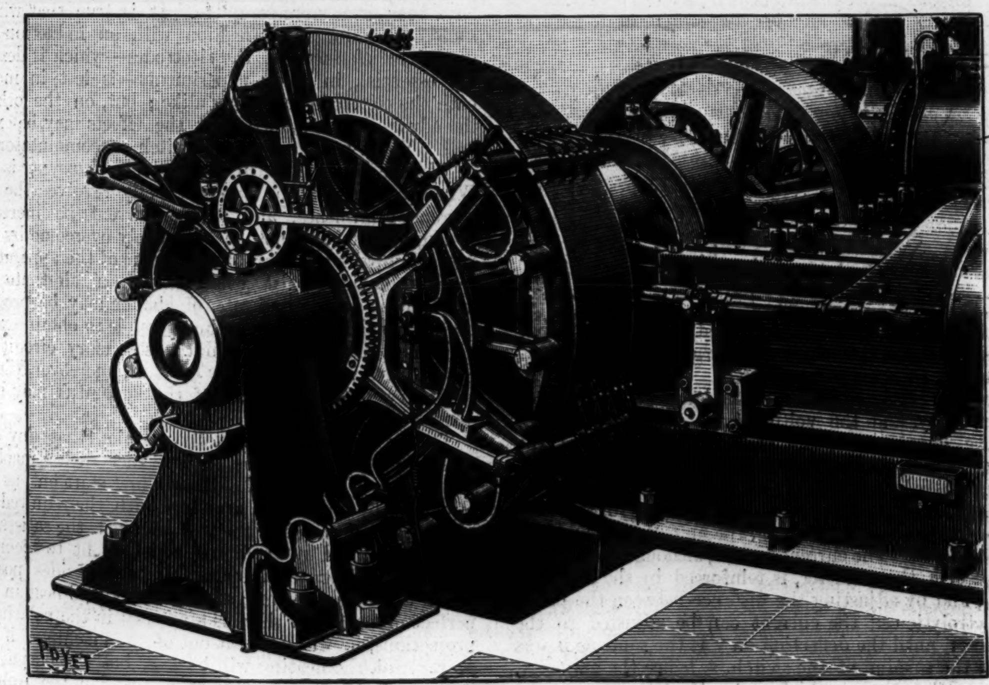
FIG. 1.

spindles of bronze, fixed on to the star, which is cast iron. Fig. 1 shows the construction of this colossal armature; fig. 2 shows the winding of it, the coil consisting of 2,000 spirals formed of rectangular bars of copper. This armature has no collector, properly so-called; the external portion of the bars with which it is wound serve to collect the current by means of eight series of brushes placed at 45° from each other. As the speed of the outer bars attains 12 metres per second, the brushes must rest very lightly in order to avoid wear and loss of work by friction. This result is obtained by mounting the brushes on flat brass springs, which gives them great flexibility. All the brushes, moreover, are mounted on one common frame, which enables them all to be brought in contact with the bars at once, and all to be at the same time brought into or displaced from the position corresponding to the suppression of the sparks, a position which varies according to the load on the machine.



Large Gramme ring being wound.

FIG. 2.



Dynamo with ring and inner poles; side view of the brushes. Type producing 160 kilowatts. The type of 350 kilowatts installed for the service of the Place Clichy differs only in its dimensions.

FIG. 3.

The brushes can be displaced longitudinally along the rods which support them, so as to distribute the friction and equalise the wear, which is, however, very slight, of the collector. Fig 3, which represents a dynamo of less power, but of the same type, shows clearly the arrangement of the armature collector and brushes, as just described. It is a type producing 160 kilowatts, used in less important stations; a model of this type was shown at the Universal Exhibition of 1889. The three large dynamos at the station of the sector of the Place Clichy differ from this type only in dimensions and power. The armature alone weighs eight tons, and special precautions had to be taken for its construction and transport from the works of the Alsatian Mechanical Constructions Company at Belfort, where it was made, to Paris. The three dynamos are connected directly, in the plan of the works, with two thick bars of copper, between which a difference of potential of from 450 to 500 volts is maintained. The excitation of each dynamo is equally established between these two bars, and may be regulated by means of a rheostat introduced into the circuit. Each rheostat may be manipulated independently in order to allow of the introduction or suppression of each machine in derivation on the bars, but all the rheostats can be connected together and manipulated at the same time for purposes of general regulation.

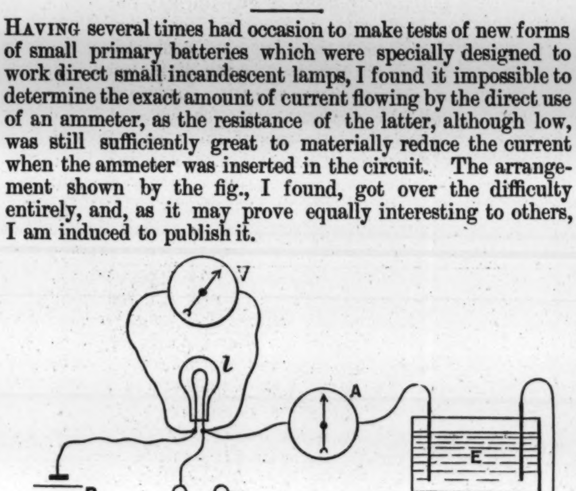
We will discuss in another article how the current thus produced is subdivided, canalised and distributed.

(To be continued.)

TESTING PRIMARY BATTERIES.

By I. PROBERT.

HAVING several times had occasion to make tests of new forms of small primary batteries which were specially designed to work direct small incandescent lamps, I found it impossible to determine the exact amount of current flowing by the direct use of an ammeter, as the resistance of the latter, although low, was still sufficiently great to materially reduce the current when the ammeter was inserted in the circuit. The arrangement shown by the fig., I found, got over the difficulty entirely, and, as it may prove equally interesting to others, I am induced to publish it.



The battery, B, to be tested, is joined up to the lamp, *l* (which has a voltmeter, V, across its terminals), the switch, S, being turned to the position shown. Under these conditions the battery works direct on to the lamp which glows at its full brilliancy, and the voltmeter, V, gives the voltage between the lamp terminals. In order to determine the current, the switch, S, is turned to the position shown by the dotted lines; this brings into circuit the auxiliary battery (I have used, preferably, small portable accumulators for this purpose, as they have a low resistance), the ammeter, A, and the electrolytic cell, E. The current from B, although reduced by the resistance of the ammeter, is reinforced by the auxiliary battery, B_1, and by adjusting the distance between the plates of the electrolytic cell the current can be adjusted to the greatest nicety, until the deflection on V is the same as it was previous to the turning of the switch, S, hence the ammeter, A, now shows the current which under the latter conditions was flowing through B. The observation being taken on A, the switch, S, is turned back to the position shown in the fig., and the battery, B, continues to work under the the practical conditions.

It should be added that by this arrangement not only can the true energy expended in the lamp be obtained for the stated candle-power, but by removing the lamp from the battery, and adapting it to a movable bridge astride a suitable mercury trough, the light can be easily measured without interposing unnecessary resistance between the battery and its lamp.

PHENOMENA OF ALTERNATING CURRENTS OF VERY HIGH FREQUENCY.

By NIKOLA TESLA.

Alternate current machines of high frequency; curious experiments with Geissler tubes and lamps; an exploded notion; noiseless alternating arcs; constant current and constant potential; interesting experiment with a condenser; the Ferranti-main effect; Da liegt der Hase im Pfeffer begraben; suggestions of Mr. Swinburne.

ELECTRICAL journals are getting to be more and more interesting. New facts are observed and new problems spring up daily which command the attention of engineers. In the last few numbers of the English journals, there have been several new matters brought up which have attracted more than usual attention. The address of Professor Crookes has revived the interest in his beautiful and skilfully performed experiments, the effect observed on the Ferranti mains has elicited the expressions of opinion of some of the leading English electricians, and Mr. Swinburne has brought out some interesting points in connection with condensers and dynamo excitation.

The writer's own experiences have induced him to venture a few remarks in regard to these and other matters, hoping that they will afford some useful information or suggestion to the reader. (*Electrical World.*)

Among his many experiments Professor Crookes shows some performed with tubes devoid of internal electrodes, and from his remarks it must be inferred that the results obtained with these tubes are rather unusual. If this be so, then the writer must regret that Professor Crookes, whose admirable work has been the delight of every investigator, should not have availed himself in his experiments of a properly constructed alternate current machine—namely, one capable of giving, say, 10,000 to 20,000 alternations per second. His researches on this difficult but fascinating subject would then have been even more complete. It is true that when using such a machine in connection with an induction coil the distinctive character of the electrodes—which is desirable, if not essential, in many experiments—is lost, in most cases both the electrodes behaving alike; but, on the other hand, the advantage is gained that the effects may be exalted at will. When using a rotating switch or commutator the rate of change obtainable in the primary current is limited. When the commutator is more rapidly revolved the primary current diminishes, and if the current be increased, the sparking, which cannot be completely overcome by the condenser, impairs considerably the virtue of the apparatus. No such limitations exist when using an alternate current machine, as any desired rate of change may be produced in the primary current. It is thus possible to obtain excessively high electromotive forces in the secondary circuit with a comparatively small primary current; moreover, the perfect regularity in the working of the apparatus may be relied upon.

The writer will incidentally mention that any one who attempts for the first time to construct such a machine will have a tale of woe to tell. He will first start out, as a matter of course, by making an armature with the required number of polar projections. He will then get the satisfaction of having produced an apparatus which is fit to accompany a thoroughly Wagnerian opera. It may besides possess the virtue of converting mechanical energy into heat in a nearly perfect manner. If there is a reversal in the polarity of the projections, he will get heat out of the machine; if there is no reversal, the heating will be less, but the output will be next to nothing. He will then abandon the iron in the armature, and he will get from the Scylla to the Charybdis. He will look for one difficulty and will find another, but, after a few trials, he may get nearly what he wanted.

Among the many experiments which may be performed with such a machine, of not the least interest are those performed with a high tension induction coil. The character of the discharge is completely changed. The arc is established at much greater distances, and it is so easily affected by the slightest current of air that it often wriggles around in the most singular manner. It usually emits the rhythmical sound peculiar to the alternate arcs, but the curious point is that the sound may be heard with a number of alternations far above 10,000 per second, which by many is considered to be about the limit of audition. In many respects the coil behaves like a static machine. Points impair considerably the sparking interval, electricity escaping from them freely, and from a wire attached to one of the terminals streams of light issue, as though it were connected to a pole of a powerful Toepler machine. All these phenomena are, of course, mostly due to the enormous differences of potential obtained. As a consequence of the self-induction of the coil and the high frequency, the current is minute while there is a corresponding rise of pressure. A current impulse of some strength started in such a coil should persist to flow no less than four ten-thousandths of a second. As this time is greater than half the period it occurs that an opposing electromotive force begins to act while the current is still flowing. As a consequence, the pressure rises as in a tube filled with liquid and vibrated rapidly around its axis. The current is so small that, in the opinion and involuntary experience of the writer, the discharge of even a very large coil cannot produce seriously injurious effects, whereas, if the same coil were operated with a current of lower frequency, though the electromotive force would be much smaller, the discharge would be most certainly injurious. This result, however, is due in part to the high frequency. The writer's experiences tend to show that the higher the frequency the greater the amount of electrical energy which may be passed through the body without serious discomfort; whence it seems certain that human tissues act as condensers.

One is not quite prepared for the behaviour of the coil when connected to a Leyden jar. One, of course, anticipates that since the frequency is high the capacity of the jar should be small. He therefore takes a very small jar, about the size of a small wine glass, but he finds that even with this jar the coil is practically short-circuited. He then reduces the capacity until he comes to about the capacity of two spheres, say, 10 centimetres in diameter and two to four centimetres apart. The discharge then assumes the form of a serrated band exactly like a succession of sparks viewed in a rapidly-revolving mirror; the serations, of course, corresponding to the condenser discharges. In this case one may observe a queer phenomenon. The discharge starts at the nearest points, works gradually up, breaks somewhere near the top of the spheres, begins again at the bottom, and so on. This goes on so fast that several serrated bands are seen at once. One may be puzzled for a few minutes, but the explanation is simple enough. The discharge begins at the nearest points, the air is heated and carries the arc upward until it breaks, when it is re-established at the nearest points, &c. Since the current passes easily through a condenser of even small capacity, it will be found quite natural that connecting only one terminal to a body of the same size, no matter how well insulated, impairs considerably the striking distance of the arc.

Experiments with Geissler tubes are of special interest. An exhausted tube, devoid of electrodes of any kind, will light up at some distance from the coil. If a tube from a vacuum pump is near the coil the whole of the pump is brilliantly lighted. An incandescent lamp approached to the coil lights up and gets perceptibly hot. If a lamp have the terminals connected to one of the binding posts of the coil and the hand is approached to the bulb, a very curious and rather unpleasant discharge from the glass to the hand takes place, and the filament may become incandescent. The discharge resembles to some extent the stream issuing from the plates of a powerful Toepler machine, but is of incomparably greater quantity. The lamp in this case acts as a condenser, the rarefied gas being one coating, the operator's hand the other. By taking the globe of a lamp in the hand, and by bringing the metallic terminals near to or in contact with a conductor connected to the coil, the carbon is brought to bright incandescence and the glass is rapidly heated. With a 100-volt 10-C.P. lamp one may without great discomfort stand as much current as will bring the lamp to a considerable brilliancy; but it can be held in the hand only for a few minutes, as the glass is heated in an incredibly short time. When a tube is lighted by bringing it near to the coil it may be made to go out by interposing a metal plate or the hand between the coil and the tube; but if the metal plate be fastened to a glass rod or otherwise insulated, the tube may remain lighted if the plate be interposed, or may even increase in luminosity. The effect depends on the position of the plate and tube relatively to the coil, and may be always easily foretold by *assuming* that conduction takes place from one terminal of the coil to the other. According to the position of the plate, it may either divert from or direct the current to the tube.

In another line of work the writer has in frequent experiments maintained incandescent lamps of 50 or 100 volts burning at any desired candle-power with both the terminals of each lamp connected to a stout copper wire of no more than a few feet in length. These experiments seem interesting enough, but they are not more so than the queer experiment of Faraday, which has been revived and made much of by recent investigators, and in which a discharge is made to jump between two points of a bent copper wire. An experiment may be cited here which may seem equally interesting. If a Geissler tube, the terminals of which are joined by a copper wire, be approached to the coil, certainly no one would be prepared to see the tube light up. Curiously enough, it does light up, and, what is more, the wire does not seem to make much difference. Now, one is apt to think in the first moment that the impedance of the wire might have something to do with the phenomenon. But this is of course immediately rejected, as for this an enormous frequency would be required. The result, however, seems puzzling only at first; for upon reflection it is quite clear that the wire can make but little difference. It may be explained in more than one way, but it agrees perhaps best with observation to assume that conduction takes place from the terminals of the coil through the space. On this assumption, if the tube with the wire be held in any position, the wire can divert little more than the current which passes through the space occupied by the wire and the metallic terminals of the tube; through the adjacent space the current passes practically undisturbed. For this reason, if the tube be held in any position at right angles to the line joining the binding posts of the coil, the wire makes hardly any difference, but in a position more or less parallel with that line it impairs to a certain extent the brilliancy of the tube and its facility to light up. Numerous other phenomena may be explained on the same assumption. For instance, if the ends of the tube be provided with washers of sufficient size, and held in the line joining the terminals of the coil, it will not light up, as then nearly the whole of the current, which would otherwise pass uniformly through the space between the washers, is diverted through the wire. But if the tube be inclined sufficiently to that line, it will light up in spite of the washers. Also, if a metal plate be fastened upon a glass rod, and held at right angles to the line joining the binding posts, and nearer to one of them, a tube held more or less parallel with the line will light up instantly when one of its terminals touches the plate, and will go out when separated from the plate. The greater the surface of the plate up to a certain limit, the easier the tube will light up. When a tube is placed at right angles to the straight line joining the binding posts, and then rotated, its luminosity steadily increases until it is parallel with that line. The writer must state, however, that he does not favour the idea of a leakage or current through the space any more than as a suitable explanation, for he is convinced that all these experiments could not be performed with a static machine yielding a constant difference of potential, and that condenser action is largely concerned in these phenomena.

It is well to take certain precautions when operating a Rhumkorff coil with very rapidly alternating currents. The primary current should not be turned on too long, else the core may get so hot as to melt the gutta-percha or paraffin, or otherwise injure the insulation, and this may occur in a surprisingly short time, the current's strength considered. The primary current being turned on, the fine wire terminals may be joined without great risk, the impedance being so great that it is difficult to force enough current through the fine wire so as to injure it, and, in fact, the coil may be on the whole much safer when the terminals of the fine wire are connected, than when they are insulated; but special care should be taken when the terminals are connected to the coatings of a Leyden jar, for with anywhere near the critical capacity, which just counteracts the self-induction at the existing frequency, the coil might meet the fate of St. Polycarpus. If an expensive vacuum pump is lighted up by being near to the coil, or touched with a wire connected to one of the terminals, the current should be left on no more than a few moments, else the glass will be cracked by the heating of the rarified gas in one of the narrow passages—in the writer's own experience *quod erat demonstrandum*.*

There are a good many other points of interest which may be observed in connection with such a machine. Experiments with the telephone, a conductor in a strong field or with a condenser or arc seem to afford certain proof that sounds far above the usual accepted limit of hearing would be perceived. A telephone will admit notes of twelve to thirteen thousand vibrations per second, then the inability of the core to follow such rapid alternations begins to tell. If, however, the magnet and core be replaced by a condenser and the terminals connected to the high-tension secondary of a transformer higher notes may still be heard. If the current be sent round a finely laminated core and a small piece of thin sheet iron be held gently against the core, a sound may be still heard with thirteen to fourteen thousand alternations per second, provided the current is sufficiently strong. A small coil, however, tightly packed between the poles of a powerful magnet, will emit a sound with the above number of alternations, and arcs may be audible with still a higher frequency. The limit of audition is variously estimated. In Sir William Thomson's writings it is stated somewhere that ten thousand per second, or nearly so, is the limit. Other, but less reliable sources, give it as high as twenty-four thousand per second. The above experiments have convinced the writer that notes of an incomparably higher number of vibrations per second would be perceived provided they could be produced with sufficient power. There is no reason why it should not be so. The condensations and rarefactions of the air would necessarily set the diaphragm in a corresponding vibration and some sensation would be produced whatever—within certain limits—the velocity of transmission to their nerve centres, though it is probable that for want of exercise the ear would not be able to distinguish any such high note. With the eye it is different; if the sense of vision is based upon some resonance effect, as many believe, no amount of increase in the intensity of the ethereal vibration could extend our range of vision on either side of the visible spectrum.

The limit of audition of an arc depends on its size. The greater the surface by a given heating effect in the arc the higher the limit of audition. The highest notes are emitted by the high-tension discharges of an induction coil in which the arc is, so to speak, all surface. If R be the resistance of an arc, and C the current, and the linear dimensions be n times increased, then the resistance is $\frac{R}{n}$, and with the same current density the current would be n^2C; hence the heating effect is n^3 times greater, while the surface is only n^2 times as great. For this reason very large arcs would not emit any rythmical sound even with a very low frequency. It must be observed, however, that the sound emitted depends to some extent also on the composition of the carbon. If the carbon contain highly refractory material, this when heated tends to maintain the temperature of the arc uniform and the sound is lessened; for this reason it would seem that an alternating arc requires such carbons.

With currents of such high frequencies it is possible to obtain noiseless arcs, but the regulation of the lamp is rendered extremely difficult on account of the excessively small attractions or repulsions between conductors conveying these currents.

An interesting feature of the arc produced by these rapidly alternating currents is its persistency. There are two causes for it, one of which is always present, the other sometimes only. One is due to the character of the current and the other to the property of the machine. The first cause is the more important one, and is due directly to the rapidity of the alternations. When an arc is formed by a periodically undulating current, there is a corresponding undulation in the temperature of the gaseous column, and, therefore, a corresponding undulation in the resistance of the arc. But the resistance of the arc varies enormously with the temperature of the gaseous column, being practically infinite when the gas between the electrodes is cold. The persistence of the arc, therefore, depends on the inability of the column to cool. It is for this reason impossible to maintain an arc with the current alternating only a few times a second. On the other hand, with a practically continuous current, the arc is easily maintained, the column being constantly kept at a high temperature and low resistance. The higher the frequency the smaller the time interval during which the arc may cool and increase considerably in resistance. With a frequency of 10,000 per second or more in an arc of same size excessively small variations of temperature are superimposed upon a steady temperature, like ripples on the surface of a deep sea. The heating effect is practically continuous, and the arc behaves like one produced by a continuous current, with the exception, however, that it may not be quite as easily started, and that the electrodes are equally consumed; though the writer has observed some irregularities in this respect.

The second cause alluded to, which possibly may not be present, is due to the tendency of a machine of such high frequency to maintain a practically constant current. When the arc is lengthened the electromotive force rises in proportion and the arc appears to be more persistent.

Such a machine is eminently adapted to maintain a constant current, but it is very unfit for a constant potential. As a matter of fact, in certain types of such machines a nearly constant current is an almost unavoidable result. As the number of poles or polar projections is greatly increased, the clearance becomes of great importance. One has really to do with a great number of very small machines. Then there is the impedance in the armature, enormously augmented by the high frequency. Then, again, the magnetic leakage is facilitated. If there are three or four hundred alternate poles the leakage is so great that it is virtually the same as connecting, in a two-pole machine, the poles by a piece of iron. This disadvantage, it is true, may be obviated more or less by using a field throughout of the same polarity, but then one encounters difficulties of a different nature. All these things tend to maintain a constant current in the armature circuit.

In this connection it is interesting to notice that even to-day engineers are astonished at the performance of a constant current machine, just as, some years ago, they used to consider it an extraordinary performance if a machine was capable of maintaining a constant potential difference between the terminals. Yet one result is just as easily secured as the other. It must only be remembered that in an inductive apparatus of any kind, if constant potential is required, the inductive relation between the primary or exciting and secondary or armature circuit must be the closest possible; whereas, in an apparatus for constant current just the opposite is required. Furthermore, the opposition to the current's flow in the induced circuit must be as small as possible in the former and as great as possible in the latter case. But opposition to a current's flow may be caused in more than one way. It may be caused by ohmic resistance or self-induction. One may make the induced circuit of a dynamo machine or transformer of such high resistance that when operating devices of considerably smaller resistance within very wide limits a nearly constant current is maintained. But such high resistance involves a great loss in power, hence it is not practicable. Not so self-induction. Self-induction does not necessarily mean loss of power. The moral is, use self-induction instead of resistance. There is, however, a circumstance which favours the adoption of this plan, and this is, that a very high self-induction may be obtained cheaply by surrounding a comparatively small length of wire more or less completely with iron, and, furthermore, the effect may be exalted at will by causing a rapid undulation of the current. To sum up, the requirements for constant current are: Weak magnetic connection between the induced and inducing circuits, greatest possible self-induction with the least resistance, greatest practicable rate of change of the current. Constant potential, on the other hand, requires closest magnetic connection between the circuits, steady induced current, and, if possible, no reaction. If the latter conditions could be fully satisfied in a constant potential machine, its output would surpass many times that of a machine primarily designed to give constant current. Unfortunately, the type of machine in which these conditions may be satisfied is of little practical value, owing to the small electromotive force obtainable and the difficulties in taking off the current.

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* It is thought necessary to remark that, although the induction coil may give quite a good result when operated with such rapidly alternating currents, yet its construction, quite irrespective of the iron core, makes it very unfit for such high frequencies, and to obtain the best results the construction should be greatly modified.

With their keen inventor's instinct, the now successful arc light men have early recognised the desideratums of a constant current machine. Their arc light machines have weak fields, large armatures, with a great length of copper wire and few commutator segments to produce great variations in the current's strength and to bring self-induction into play. Such machines may maintain within considerable limits of variation in the resistance of the circuit a practically constant current. Their output is, of course, correspondingly diminished, and, perhaps, with the object in view not to cut down the output too much, a simple device compensating exceptional variations is employed. The undulation of the current is almost essential to the commercial success of an arc-light system. It introduces in the circuit a steadying element taking the place of a large ohmic resistance, without involving a great loss in power, and, what is more important, it allows the use of simple clutch lamps, which with a current of a certain number of impulses per second, best suitable for each particular lamp, will, if properly attended to, regulate even better than the finest clockwork lamps. This discovery has been made by the writer—several years too late.

It has been asserted by competent English electricians that in a constant current machine or transformer the regulation is effected by varying the phase of the secondary current. That this view is erroneous may be easily proved by using, instead of lamps, devices, each possessing self-induction and capacity, or self-induction and resistance—that is, retarding and accelerating components—in such proportions as to not affect materially the phase of the secondary current. Any number of such devices may be inserted or cut out; still it will be found that the regulation occurs, a constant current being maintained, while the electromotive force is varied with the number of the devices. The change of phase of the secondary current is simply a result following from the changes in resistance, and, though secondary reaction is always of more or less importance, yet the real cause of the regulation lies in the existence of the conditions above enumerated. It should be stated, however, that in the case of a machine the above remarks are to be restricted to the cases in which the machine is independently excited. If the excitation be effected by commutating the armature current, then the fixed position of the brushes makes any shifting of the neutral line of the utmost importance, and it may not be thought immodest of the writer to mention that, as far as records go, he seems to have been the first who has successfully regulated machines in providing a bridge connection between a point of the external circuit and the commutator by means of a third brush. The armature and field being properly proportioned, and the brushes placed in their determined positions, a constant current or constant potential resulted from the shifting of the diameter of commutation by the varying loads.

In connection with machines of such high frequencies the condenser affords an especially interesting study. It is easy to raise the electromotive force of such a machine to four or five times the value by simply connecting the condenser to the circuit, and the writer has continually used the condenser for the purposes of regulation as suggested by Blakesley in his book on alternate currents, in which he has treated the most frequently occurring condenser problems with exquisite simplicity and clearness. The high frequency allows the use of small capacities and renders investigation easy. But, although in most of the experiments the result may be foretold, yet some phenomena observed seem at first curious. One experiment performed three or four months ago with such a machine and a condenser may serve as illustration. A machine was used giving about 20,000 alternations per second. Two bare wires of about 20 feet long and two millimetres diameter, in close proximity to each other, were connected to the terminals of the machine on the one end, and to a condenser on the other. A small transformer without an iron core, of course, was used to bring the reading within the range of a Cardew voltmeter by connecting the voltmeter to the secondary. On the terminals of the condenser the electromotive force was about 120 volts, and from there inch by inch it gradually fell until on the terminals of the machine it was about 65 volts. It was virtually as though the condenser were a generator, and the line and armature circuit simply a resistance connected to it. The writer looked for a case of resonance, but he was unable to augment the effect by varying the capacity very carefully and gradually or by changing the speed of the machine. A case of pure resonance he was unable to obtain. When a condenser was connected to the terminals of the machine—the self-induction of the armature being first determined in the maximum and minimum position and the mean value taken—the capacity which gave the highest electromotive force corresponded most nearly to that which just counteracted the self-induction with the existing frequency. If the capacity was increased or diminished, the electromotive force fell as expected.

With frequencies as high as the above-mentioned, the condenser effects are of enormous importance. The condenser becomes a highly efficient apparatus capable of transferring considerable energy.

The writer has thought that machines of high frequencies may find use at least in cases when transmission at great distances is not contemplated. The increase of the resistance may be reduced in the conductors and exalted in the devices when heating effects are wanted; transformers may be made of higher efficiency and greater outputs, and valuable results may be secured by means of condensers. In using machines of high frequency the writer has been able to observe condenser effects which would have otherwise escaped his notice. He has been very much interested in the phenomenon observed on the Ferranti main, which has been so much spoken of. Opinions have been expressed by competent electricians, but up to the present all still seems to be conjecture. Undoubtedly in the views expressed the truth must be contained, but, as the opinions differ, some must be erroneous. Upon seeing the diagram of M. Ferranti in the *Electrician* of December 19th, the writer has formed his opinion of the effect. In the absence of all the necessary data he must content himself to express in words the process which, in his opinion, must undoubtedly occur. The condenser brings about two effects: (1) it changes the phases of the currents in the branches; (2) it changes the strength of the currents. As regards the change in phase, the effect of the condenser is to accelerate the current in the secondary at Deptford, and to retard it in the primary at London. The former has the effect of diminishing the self-induction in the Deptford primary, and this means lower electromotive force on the dynamo. The retardation of the primary at London, as far as merely the phase is concerned, has little or no effect, since the phase of the current in the secondary in London is not arbitrarily kept.

Now, the second effect of the condenser is to increase the current in both the branches. It is immaterial whether there is equality between the currents or not; but it is necessary to point out, in order to see the importance of the Deptford step-up transformer, that an increase of the current in both the branches produces opposite effects. At Deptford it means further lowering of the electromotive force at the primary, and at London it means increase of the electromotive force at the secondary. Therefore all the things co-act to bring about the phenomenon observed. Such actions, at least, have been formed to take place under similar conditions. When the dynamo is connected directly to the main, one can see that no such action can happen.

The writer has been particularly interested in the suggestions and views expressed by Mr. Swinburne. Mr. Swinburne has frequently honoured him by disagreeing with his views. Three years ago, when the writer, against the prevailing opinion of engineers, advanced an open circuit transformer, Mr. Swinburne was the first to condemn it by stating in the *Electrician*: "The (Tesla) transformer must be inefficient; it has magnetic poles revolving, and has thus an *open* magnetic circuit." Two years later Mr. Swinburne becomes the champion of the open circuit transformer, and offers to convert him. But, *tempora mutantur, et nos mutamur in illis.*

The writer cannot believe in the armature reaction theory as expressed in *Industries*, though undoubtedly there is some truth in it. Mr. Swinburne's interpretation, however, is so broad that it may mean anything.

Mr. Swinburne seems to have been the first who has called attention to the heating of the condensers. The astonishment expressed at that by the ablest electrician is a striking illustration of the desirability to execute experiments on a large scale. To the scientific investigator, who deals with the minutest quantities, who observes the faintest effects, far more credit is due than to one who experiments with apparatus on an industrial scale; and indeed history of science has recorded examples of marvellous skill, patience and keenness of observation. But however great the skill, and however keen the observer's perception, it can only be of advantage to magnify an effect and thus facilitate its study. Had Faraday carried out but one of his experiments on dynamic induction on a large scale it would have resulted in an incalculable benefit.

In the opinion of the writer the heating of the condensers is due to three distinct causes: first, leakage or conduction; second, imperfect elasticity in the dielectric, and, third, surging of the charges in the conductor.

In many experiments he has been confronted with the problem of transferring the greatest possible amount of energy across a dielectric. For instance, he has made incandescent lamps the ends of the filaments being completely sealed in glass, but attached to interior condenser coatings so that all the energy required had to be transferred across the glass with a condenser surface of no more than a few centimetres square. Such lamps would be a practical success with sufficiently high frequencies. With alternations as high as 15,000 per second it was easy to bring the filaments to incandescence. With lower frequencies this could also be effected, but the potential difference had, of course, to be increased. The writer has then found that the glass gets, after a while, perforated and the vacuum is impaired. The higher the frequency the longer the lamp can withstand. Such a deterioration of the dielectric always takes place when the amount of energy transferred across a dielectric of definite dimensions and by a given frequency is too great. Glass withstands best, but even glass is deteriorated. In this case the potential difference on the plates is of course too great and losses by conduction and imperfect elasticity result. If it is desirable to produce condensers capable to stand great differences of potential, then the only dielectric which will involve no losses is a gas under pressure. The writer has worked with air under enormous pressures, but there are a great many practical difficulties in that direction. He thinks that, in order to make the condensers of considerable practical utility, higher frequencies should be used; though such a plan has besides others the great disadvantage that the system would become very unfit for the operation of motors.

If the writer does not err, Mr. Swinburne has suggested a way of exciting an alternator by means of a condenser.

For a number of years past the writer has carried on experiments with the object in view of producing a practical self-exciting alternator. He has in a variety of ways succeeded in producing some excitation of the magnets by means of alternating currents, which were not commutated by mechanical devices. Nevertheless, his experiments have revealed a fact which stands as solid as the rock of Gibraltar. No practical excitation can be obtained with a single periodically varying and not commutated current. The reason is that the changes in the strength of the exciting current produce corresponding changes in the field strength, with the result of inducing currents in the armature; and these currents interfere with those produced by the motion of the armature through the field, the former being a quarter phase in advance of the latter. If the field be laminated, no excitation can be produced; if it be not laminated, some excitation is produced, but the magnets are heated. By combining two exciting currents displaced by a quarter phase, excitation may be produced in both cases, and if the magnet be not laminated the heating effect is comparatively small, as a uniformity in the field strength is maintained, and, were it possible to produce a perfectly uniform field, excitation on this plan would give quite practical results. If such results are to be secured by the use of a condenser, as suggested by Mr. Swinburne, it is necessary to combine two circuits separated by a quarter phase; that is to say, the armature coils must be wound in two sets and connected to one or two independent condensers. The writer has done some work in that direction, but must defer the description of the devices for some future time.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"TRANSFORMER DISTRIBUTION." By J. SWINBURNE, Member.

(*Continued from page* 269.)

We may now examine the question of parallel running from the armature reaction point of view. Though it may be out of its proper place in the paper, the question of motors may be to some extent discussed at the same time.

Suppose, as in the first case, a pair of terminals in connection with a station, so that the electromotive force on them is independent of any current, or of the machine under discussion connected to them. It is necessary to keep clear, for the moment, of any ideas connected with L. The armature circuit must be regarded as devoid of "self-induction."

A machine without friction may be imagined, and when its field magnets are separately excited, so as to give an electromotive force exactly equal to that of the mains when it is connected so as to be in step, it runs as a motor taking no current. At each instant the electromotive force of the machine is exactly equal to the electromotive force of the mains, so no current passes. On putting on some load the machine begins to lag. As soon as the machine lags, a current passes through the armature. The current due to the difference of two equal alternating electromotive forces is not in step with either of them. This is shown in fig. 6, where two pressure curves are drawn a little out of step. The current through resistance is proportional to the shaded parts. If the electromotive force of the machine were still the same as that of the mains, it would still develop no power as a motor, because at some parts of the period it would be supplying power to the mains, and at other parts the mains would be supplying power to the armature; for at any instant the armature current would be equal to the difference of the two electromotive forces divided by the resistance of the armature. The average current curve is shown in fig. 7. The electromotive force of the machine does not, however, remain equal to the main electromotive force, merely differing from it in phase, but is decreased by the reaction of the armature current on the field magnets. The average current curve shows that there would be considerable back induction, or many ampère turns tending to weaken the field. This weakening of the field by the armature reaction allows the main also to supply a current against the electromotive force of the machine, so that it acts as a motor, and power can be taken from it. If the load is altered, the machine will increase or decrease its lag, so that its effective field is reduced to just the right value to allow the machine to absorb electrically the power taken from it mechanically. As lag is necessary in order to weaken the effective field, so the current in the armature is no longer in step with the electromotive force of the mains. The result of this is that it is not at the maximum value at the same instants as the electromotive force is; so that the power taken by the motor is less than the product of the effective electromotive force of the mains and the effective current of the machine. The electromotive force and current may be so much out of step that the power of the motor is small, though the armature current is large. The availability of the machine as a motor thus depends on the resistance of the armature, and on its reaction on the field. For instance, if the machine has very little armature resistance, a very small reduction of its electromotive force will allow a large armature current to pass. If, on the other hand, the armature resistance is high, the armature must have a large reaction on the field so as to reduce the effective electromotive force. If, at the same time as the load is put on, the field of the motor is artificially weakened by reducing the excitation—for instance, by the insertion of resistance in the field circuit—the electromotive force of the machine may be reduced enough to allow current from the mains to act in step with the main electromotive force. For instance, if the supply circuit is of 2,000 volts, and if an ordinary separately excited 2,000-volt machine is connected, and excited so as to give 2,000 volts with the same frequency, and if this machine is loaded as a motor with 40,000 watts, or 54 horse-power, it will lag until the field is weakened enough to let enough current pass to give the power. This current will be more than 20 ampères. But if the machine as a dynamo can

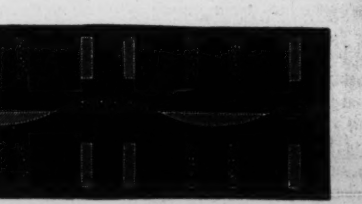

FIG. 6.

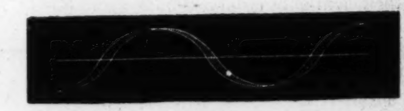

FIG. 7.

give 20 ampères with the loss of 100 volts in the armature, due to the resistance, and if the machine is excited so as to give 1,900 volts on open circuit at the normal speed, and is then thrown into the circuit at an instant when it is in step, and a load of 38,000 watts, or 51 horse-power, taken out, it will remain in step; for the electromotive force of the machine is always just enough below the main electromotive force to allow the right current to pass. The effective current is then 20 ampères. The main circuit thus supplies 2,000 volts and 20 ampères. 2,000 watts are lost in overcoming the resistance of the armature, and 38,000 are available at the pulley. The losses by friction and Foucault currents are here neglected for the sake of simplicity. In practice a little less that 51 horse-power would be obtained for external use. If the field has not been weakened by reducing the excitation, the effective current—that is to say, the root of the mean square of the current, or the current as measured by an electro-dynamometer—would be more than 20 ampères, so that there would be extra loss of power in the armature.

If the machine is to be worked as a generator in parallel with the main circuit—that is to say, if it is to supply power to the mains instead of to take it from them—the same reasoning holds good. If the machine is excited so as to give 2,000 volts at no load, and is thrown into circuit at an instant when it is in step—if the engine supplies just enough power to overcome friction, there will be no armature current, as the electromotive force of the machine will, at every instant of the period, be exactly equal and opposite to that of the mains. If the engine supplies just a little too much power, the machine will begin to lead, and an armature current will pass, which will strengthen the fields by reaction, and the machine will at some instants act as a generator, because its electromotive force is now a little higher, as the armature currrent has strengthened its field. Similarly, if the steam of the engine were completely shut off, the machine would lag until it worked as a motor. If now the steam is turned on until the dynamo supplies 40,000 watts to the mains, the machine will increase its lead until the armature current strengthens the field enough to give the full output. The armature current must be out of step with the electromotive force of the machine.

In these examples back induction has alone been considered; but the effect of cross induction must also be taken into account. Cross induction, in the case when the machine is working as a dynamo, makes the current lag. This weakens the field, and counterbalances to some extent the effect of the leading current, due to the pressures being out of step. A still greater lead is therefore necessary to make the machine work as a dynamo. Suppose, however, that the field excitation is strengthened to balance this back induction, as well as the loss by armature resistance—that is to say, suppose it is excited to give 2,000 volts, and 20 ampères on resistance, in spite of the armature reactions—it will run in step on the mains.

It is thus possible by altering the field excitation of such dynamos to make them work well as generators or motors on supply circuits. Instead of depending on the reaction of the armature to strengthen or weaken the field, the field excitation may be automatically regulated, so that the current and electromotive force of the machine are always in step, or very nearly so.

Take first the case of a separately excited motor. The field magnets may have an additional set of coils, and these are put in series with the main armature current, which is redressed or rectified by a commutator. These coils are arranged so as to demagnetise or weaken the field as the current increases, so that it is not necessary for the machine to lag in order to take a large load.

The machine may be made to excite itself. In that case, special exciting coils on the main armature are provided. These are connected with the circuit for exciting the field magnet. If a machine made in this way is used as a motor without a series demagnetising circuit round the field magnets, it begins to lag as soon as load is put on, and the armature current then reacts on the fields and weakens them. As the exciting coils now pass through the same field, this will also lessen the field excitation directly; and as soon as the field is weakened by the armature reaction, the ampère-turns round are also reduced, because the electromotive force in the exciting circuit is lessened. A very small lag will thus weaken the field considerably, so that a large load may be put on without the lag being great enough to make the machine inefficient. A series demagnetising circuit may be used in addition. If the ampère-turns of the field-magnet are not adjusted to the load with perfect accuracy, the machine adjusts itself by lagging or leading very slightly.

Machines with fields excited chiefly by special exciting circuits on the main armatures, and partly by series circuits, may be specially useful for working in parallel as generators. The series circuits are then arranged to magnetise instead of demagnetise. If power is applied to a motor instead of taken from it, it becomes a generator, and the direction of its main current is reversed, both in the armature and the series coils on the fields; so that a motor with a backward series circuit becomes a generator with a forward series circuit. If one machine when used as a generator begins to lead because too much power is supplied to it by its engine, its field is strengthened by the series circuits, and this increases the armature electromotive force enough to make it give a large output corresponding to the power supplied to it. If machines excited from special armature circuits, without series circuits, are run in parallel, they will keep in step, because the least leading or lagging alters the field excitation.

The compound form is best, because the whole station will then supply the mains at constant pressure, if all the engines are mechanically governed for constant speed of one of them—that is to say, if the whole steam supply is regulated to keep the speed of all the engines constant, the engines taking the steam in proportion to their size. Instead of keeping the speed constant, an electric governor can keep the electromotive force of the whole station constant. With alternate machines as at present commonly used, it is necessary to alter the field excitation by hand or by automatic gear. Such machines as those described have advantages corresponding to those of compound direct current dynamos, compared with shunt or separately excited machines. The analogy between these machines and compound or shunt direct current machines must not be used too far. In direct current machines, the electromotive force adapts itself by slight alterations of speed, and the armature reaction depends on the position of the brushes; in alternate machines, the speed is unalterable, and the armature reaction depends on lead and lag.

Prof. E. Thomson tells me that he has been accustomed to send out separate and series excited machines for working in parallel, and that they will work either with or without "equalising connections," such as are needed with direct compound machines. They also work well as motors, and so do the self-exciting machines with separate exciting armature circuits. He also finds the ordinary Thomson-Houston machines works efficiently as a motor.

In discussing such questions, however, we must always remember that the size of the machine is most important. A small dynamo has high resistance, small cross induction, and small armature reaction, A large machine has a small resistance and great armature reaction. Large machines may therefore easily run well in parallel or as motors, without automatically varied field excitations. A very small lagging current will reduce the field of a large machine 3 or 4 per cent., and the extra loss of power in the armature is small; for if C is the component of the current that is in step, and c the lagging component, the power wasted in the armature is not $r\,(C + c)^2$, but $r\,C^2 + r\,c^2$—a very different matter.

The case of motors, however, is not the same. A two-horse or one-horse motor is about the size that is most needed. There is no opening for 100-kilowatt motors on supply circuits just now, In these small sizes c will be very large compared with C, so automatic regulation of the field may be of the highest consequence.

The subject of motors is of enormous importance, and is most interesting. I fear it cannot be pursued here, for want of time. It is to be hoped one of my hearers may be induced to write a paper on this subject at an early date, unless, as is probable, it is exhausted in Mr. Kapp's Cantor lectures.

According to the armature reaction theory, then, whether a machine will run in parallel with others depends on its armature resistance and armature reactions. It must be borne in mind that most machines have cast iron fields, and though that may make no difference according to the orthodox theory, it does from the armature reaction point of view. If the field magnets do not quickly respond to the armature reactions, it may be difficult or impossible to run machines in parallel.

Another important consideration is the government of the engines. If two engines are working two machines in parallel at 200 revolutions, and one governor is set for 200 and the other for 195 revolutions,—if the governors are truly isochronous, one engine and dynamo will supply the whole of the power, and the other will be dragged round idle. The whole question of the government of central stations requires the most careful consideration. I have dealt with the matter at some length elsewhere,* but the subject should be very fully thought out in designing stations.

ARRANGEMENT OF STATION.

Whatever system of distribution be used outside the station, the power leaves by high-pressure leads. In this country 2,000 volts is the pressure commonly employed; in America, 1,000. I cannot help thinking that the Americans are right. The use of 2,000 volts does not decrease the cost of copper so very much, and it increases the cost of insulation enormously. In addition to this, it increases the dangers of breakdowns, and the chance of danger to life. 2,000 volts seems to have been chosen in the early days, when people had very little idea of the commercial difficulties of high pressure insulations. In addition to this, high pressure increases the cost of transformers as well as dynamos, and also lessens the output for a given size.

If the machines are employed in parallel, they may feed into common bars, as in the case of direct currents. If each district must have its own circuit—which seems to be generally assumed necessary—each circuit may be led away from the common bars with a transformer regulator in it. One objection that has been raised against parallel working is that, if each district has its own system, it may have an earth on one lead without disaster, while, if the station is in parallel, two leaks in the whole system cause a breakdown. This objection comes from America, where they have had a great deal of experience, but it seems to assume the leads to be in a very bad state. There is no need for such danger, however, for each district may be fed through a transformer; so that it has no metallic connection with the system of any other district. It is most difficult to understand why central station machines are made to give high pressures to begin with. In most forms of dynamos 2,000-volt insulation adds very materially to the cost of the machine, and lessens the output for a given size in addition. The difference of cost would more than cover the extra cost of transformers, as large converters can be made for considerably under £1 per 1,000 watts; and the efficiency, when very large, is very high, being above 99 per cent. at full load. So that the efficiency of a low pressure dynamo and transformer is higher than that of a high pressure dynamo working direct. It is also a great advantage to have all the switches, connections, and measuring instruments on the low pressure side. The high pressure circuits may then be arranged to have no metal exposed anywhere. If each district must have its separate circuit, it has its own step-up transformer, with its regulator. If feeders are used on any system, each feeder has its step-up transformer, which is made adjustable; or it may have an unadjustable transformer and a feeder regulator such as that designed by Mr. Kapp. If the district is large, it may have large transformers. Several feeders may then come off in parallel, each feeder having its own regulator. The regulators may have the adjustable parts connected with the low pressure supply, so as to avoid high pressure switches or other gear.

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* *Industries*, September, 1890.

One arrangement is shown in fig. 8. The dynamos are all in parallel, and wound for 100 volts, the immediate neighbourhood of the station being fed direct. Each feeder circuit has a transformer with a variable number of primary turns. A compensated voltmeter is placed on each, and all the attendant has to do is to alter the switches a little occasionally, so as to keep all the instruments' pointers vertical.

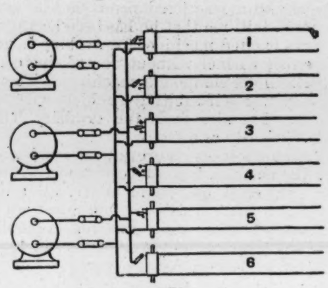

FIG. 8.

Transformers.

It is not my intention to go into the question of leads, as I am informed that a paper specially devoted to that important subject is to be read here very shortly; I am therefore most happy to leave the very special question of high pressure alternate current mains in far abler hands.

Before discussing the relative merits of house transformers, low pressure direct from the station, and various sub-station arrangements for distribution, it will be best to consider the vexed question of the transformers themselves.

In 1884 electrical engineers were surprised to learn from Dr. Hopkinson that the Gaulard and Gibbs transformers gave something like 90 per cent. full load efficiency. Since then alternating work has developed enormously; but a complete change has come over the transformers; they are almost always made with the iron circuit closed on itself. The closed iron circuit has been regarded as an enormous advance on the old form; but it is difficult to find any definite statement as to where the advantage comes in. It was for a long time assumed that almost any closed circuit transformer would give an efficiency of something like 98 per cent.—in fact, that the loss in transformers might be neglected.

In a discussion on the relative merits of direct and alternate current distribution, Mr. Crompton said that the efficiency of the ordinary commercial transformer in a station was about 50 per cent.; and I need hardly say he was not believed. He laid particular stress on the small proportion of the total number of lamps installed really used. The loss in the iron in transformers has till lately been very much overlooked; if it is even a small percentage of the full load of the transformer, it mounts up very seriously in station work when the transformers are in circuit all day and all night.

I had the honour of reading a paper before the British Association in 1889, in which the question of design for all-day loads was, as far as I know, discussed fully for the first time; and the relative proportions of iron and copper for closed circuit transformers which gave the best results were given. At the same time I pointed out that the loss in iron was really such a serious matter that by a special design not only can a very much higher efficiency be obtained at light loads, but that even at full load a new form is better in every way.

The principle of the "Hedgehog" transformer is this: By using an open circuit the iron can be reduced in volume with a given induction. The mean length of the iron part of the magnetic circuit is considerably less, and more copper turns can be wound on without increasing this length much. The additional turns admit of a smaller cross section of core, so that the iron is enormously reduced. The loss in copper is somewhat increased; but, as the loss in copper is only serious at full load, this does not matter.

The old Gaulard and Gibbs form of transformer had the disadvantage of requiring a very large exciting current. Increased number of turns of copper reduces the exciting current; but, in addition, the ends of the core are spread out in a peculiar way, which again reduces the exciting current. The result is that the exciting current, though larger than in the case of closed circuit transformers, is not a serious matter. The loss in copper is considerably smaller than the loss in iron in most closed circuit transformers, and, as it varies as the square of the current, it is inappreciable except at full load, which very seldom occurs. The loss in iron is very small, so that the loss per day in ordinary working is very much smaller than in the case of closed circuit transformers. Since my paper at the British Association, many makers have altered the proportion of their transformers considerably; but still it is impossible to get as good results with closed circuits.

Perhaps the best way I can make this clear is by a comparison of actual transformers. I am here confronted by a difficulty. If I select any particular closed circuit transformer of a particular maker, all the other makers of closed circuit transformers would say that I had chosen a bad example; while the maker himself would say that it was an old form, or that he now uses a quality of iron which wastes no power by hysteresis.

A great deal of unnecessary mystery has been made about the efficiency of transformers, and all sorts of roundabout ways of measuring or calculating it have been proposed, and sometimes tried. The matter is simple, however. The loss in the copper can be calculated if the resistance and current are known. The loss in iron in a given type of transformer depends on the quality of the sample used just as much as the loss in the copper depends on the quality of the copper used. I will therefore assume the ordinary "96 per cent." quality of copper, and I will assume that the iron is as good as the soft iron tested by Prof. Ewing. I have the best reasons for knowing that the iron used is generally much below this standard, so this assumption is considerably in favour of the closed circuits. Moreover, I am giving away the loss by Foucault currents, which is often considerable. Of course, anyone is at liberty to assume that he has some particularly good iron; but in discussing the relative value of the two types of transformer, he must allow me the same quality of iron. In fact, I might assume a special quality of copper equally unknown to the trade in mine.

As an average size of transformer, one taking 2,000 volts and a frequency of 100, and giving 15 ampères at 100 volts, may be taken, and the working compared.

Though the theory of the "Hedgehog" transformer was fully discussed in the British Association paper referred to, it may not be out of place to describe the construction of the commercial article.

A gun metal casting forms the backbone of the transformer. It is cross shape in section, and at one end is spread out to form four legs. It also supports the lower flange, or cheek, of the winding. The four spaces have bundles of soft iron wire put in, so that the core is practically cylindrical. The cross-shaped core has been criticised on the ground that there are Foucault currents in it. The least consideration will show that there is no change of induction in it, and therefore no Foucault currents. The iron wire is bound tightly, and the two flanges are slipped into place. A gun metal "spider" is then screwed to the top. It is finally held on by the eye belt, but temporarily a set screw is used. The core is then wound in a special lathe in the usual way. Both the terminal board and the coil flanges gave us a great deal of trouble till we found suitable materials, There is a great need of good insulating materials that will not warp, that will insulate perfectly, and that can be worked.

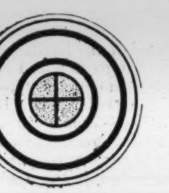

FIG. 9.

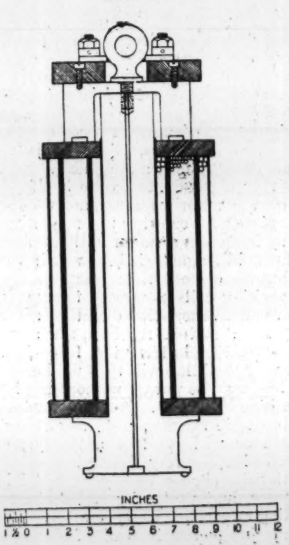

FIG. 10.

The electrical particulars of a 50 8-candle-power lamp transformer are as follows:—

Core, 13·5-in. long, 2·5-in. diameter. In taking the area of the core, allowance must be made for the space occupied by the backbone, and for the loss of room in using round wires. Maximum induction, 4,800. Loss of power in iron, assuming it to be of good quality, 13·5 watts. Primary, 3,920 turns of copper wire, 0·042-in. diameter; resistance, 37 ohms (warm). Secondary, 200 turns, 19/0·042-in.; resistance, 0·098 ohm. Loss of power in primary at full load, due to the transformed current, 21 watts; loss due to the exciting current—0·3 ampère—which is always on, 3·6 watts; loss in secondary at full load, 22 watts. Efficiency at full load, 96·15.

This transformer is shown to scale in figs. 9 and 10.

Fig. 11 is a scale drawing of a closed circuit transformer I have taken as representative. The primary is 400 turns of 0·042-in. wire, and the secondary 20 turns of 0·176-in. The loss in copper at full load is 11·3 watts, and the loss in the iron 120 watts. At full load the efficiency is 91·95, or nearly 92 per cent. The diagram (fig. 12) shows the percentage loss at various loads of the two transformers

The ordinates are percentage loss, and the abscissæ fractions of full load. Curve II. is the "Hedgehog," and IV. is the closed circuit. It will be noticed that the "Hedgehog's efficiency increases slightly at first, and keeps above 95 per cent. till the load is reduced to one-fifth, and above 90 down to one-tenth load, and it then begins to fall more rapidly. The efficiency of the closed form, however, begins to fall at once, and falls rapidly. In house work the full-load efficiency is a matter of little or no consequence; the loss at very light loads is really important. A house that has a 50-light transformer is wired for 50 lamps, and that is the maximum load. As a rule, there are seldom more than 25 lamps on at any one time, and these are on during the evening only. The average load varies with the time of year, and with the class of house. Shops, for instance, have full load for a short time each day; private houses have the lights in the hall and passages on the whole evening, with either the dining or drawing room, and for some time both the dining and drawing rooms are on. It will be a fair average if we take four hours of half-load per day as the output of house transformers. This means an efficiency of 83·3 per cent. for the "Hedgehog," and only 51 per cent. for the closed circuit. In other words, the waste in the closed circuit is between five and six times as great as in the open circuit.

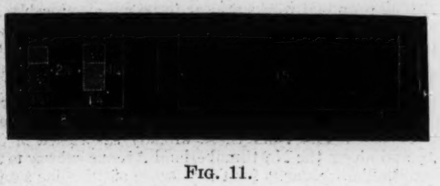

FIG. 11.

It will, I have no doubt, be urged that various published tests have shown closed circuit transformers to have efficiencies of, say, 95 per cent. I have elsewhere* examined some of these tests, and shown that, according to the figures given, the results can only be accounted for by the iron acting as freezing mixture, and supplying power to the transformer, the total loss given being in some cases less than the loss by copper resistance. In some other cases too few data are given, so that it is impossible to say how the figures are obtained. In order that an efficiency test can be taken as reliable it must contain full particulars of the transformer. It is then possible to see whether the supposed efficiency of 95 per cent. is due to the type of transformer, to inaccuracies in the measurements, or to phenomenal iron. Of course it is not impossible some one may discover phenomenal iron which will be the salvation of closed-circuit transformers, but it will have to be very good. In fig. 12, Curve III., represents the loss in a closed-circuit transformer with phenomenal iron having a loss of only 60 watts, or half that taken in the example. The dotted curved (I.) belongs to the open-circuit transformer with the same quality of iron; for, of course, the phenomenal iron is available for both. It will be seen that the ratio of the percentage losses is sensibly the same, so that the open circuit transformer is improved nearly as much as the closed. In the case taken of half load for four hours a day, the loss in the closed circuit comes out more than four times that in the open, even without re-designing the "Hedgehog." There is thus no chance of iron being found good enough to allow the closed circuit form to compete with the open. There is one objection to the "Hedgehog" which must not be passed over, and that is the exciting current. The exciting current in the 50-lighter is 0·31; in the closed circuit it is 0·2; so that it is quite half as much again. Moreover, if a better quality of iron is discovered, it will lessen the exciting current in the closed circuit, but will make no perceptible difference in the open, unless it is re-designed. The exciting current does harm in two ways: it weakens the field of the dynamos at the central stations, and it gives rise to troubles in the station at light loads. For instance, if a station had 10 dynamos to run the full load, in the daytime three would be required to supply the exciting current, while in the closed circuit two would do. If the dynamos are direct driven, this means three engines running light instead of two; and engines running light are very wasteful. These difficulties are, however, to a large extent imaginary. The weakening of the fields is, in ordinary working, counteracted by stronger excitation. Running three dynamos instead of two or one does not involve running three engines: the engine should be uncoupled and the dynamos run as 'idle' motors, supplying the exciting current necessary for the transformers. In the future, it is to be hoped that alternate motors will be used; and as they will be used chiefly during the times the load on the transformers is light, they will thus supply the exciting currents, and it will be unnecessary to run any idle dynamos. It must be remembered that the difference is only one of degree. Closed circuit transformers have very considerable exciting currents; but it is most desirable to avoid any troubles, whichever kind is used. The solution of the difficulty lies in the employment of condensers. A condenser supplies the exciting current, so that the station dynamos supply a current sensibly proportional to the power used. Thus, in the daytime, with open circuit transformers, a very small engine and dynamo will give all that is needed. More will be said about condensers presently.

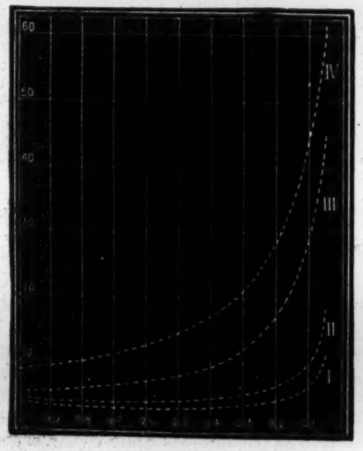

FIG. 12.

DISTRIBUTION.

Even with the most efficient transformers, the house system is a very poor method of distribution. Apart from the question of loss of power, consider the outlay involved in providing each consumer with a high-pressure double-pole fuse, a transformer, an automatic device for rendering the whole arrangement safe in case of insulation giving way, perhaps a double-pole main switch, a meter, and a fireproof safe in which all these things have to be enclosed. In addition to this, it involves a complete high-pressure parallel system of distribution, and a network of 2,000-volt underground mains, involving a heavy outlay, and probably heavy depreciation. The adoption of sub-stations is generally regarded as the cure for all this. I believe no sub-station distribution is in use, or even in construction, in this country. The London Electric Supply Company are using sub-stations, but not in this way. These sub-stations merely transform from 10,000 to 2,500 volts, and the distribution itself is carried out by means of house transformers. The principle of sub-stations is that the town has a network of low-pressure mains, with low-pressure feeders led to sub-stations. In each sub-station there are attendants who regulate the pressure in the network, as they have control of the feeders. The sub-station is supplied by high-pressure mains from the station, the power being transformed to low pressure at the sub-stations. There is, however, no need for sub-stations; the low-pressure network may be fed at various points by transformers and feeders coming direct from the station. These transformers need not be in houses or cellars; they can be placed conveniently in the ground in cases filled with insulating oil. The method of feeding into a low-pressure network was described in Mr. Kapp's paper on transformers in 1888, and he referred to it as being in use on the continent and in America. At the station each feeder can be regulated, and has a compound-wound voltmeter, so that an attendant can keep the presure in the whole town constant. As Mr. Kapp pointed out, the advantage of such a system is enormous. In direct currents the low-pressure mains must be large. The great size needed for parallel distribution was pointed out at the time of the Electric Light Act of 1882, and Prof. Forbes afterwards went into the matter much more fully; but even now the enormous saving that can be effected by using small low-pressure mains fed at frequent intervals seems hardly to be realised.

In beginning in a new district it may be objected that the subscribers at first are so few that it does not pay to put down low pressure mains. This would be true if alternate low pressure had to be as large as direct current mains. Without going into the cost of a particular case, it is probable that low pressure mains, large enough to supply any demand likely to arise for many years, can be put down for little, if any, more than the high pressure network with its expensive insulation. Even in scattered districts it would generally pay to use small low pressure mains and feeders. The alternate system has so many advantages over the direct in the matters of regulation and distribution, when worked on the low pressure system, that it is astonishing that such arrangements are not utilised. For instance, with direct currents, it is most difficult to find a leak; and one leak on the positive at the west end, combined with one leak on the negative at the east, will cause serious trouble. With alternate currents, a number of small local networks may be used, each of them being complete in itself. It is not in metallic connection with any other part of the town, nor with the central station. Where it meets the network of the neighbouring district it is not metallically joined, as in the case of direct currents, but is connected through a one-to-one transformer sunk in the ground, in a case full of oil.

After the clear and able manner in which Mr. Kapp urged the advantages of low pressure networks for alternating currents, it is most astonishing that engineers should go on with house transformers. With the low pressure network system we have everything that can be wanted. Perfect regulation at every point throughout the town, small mains, inexpensive insulation, cheap and efficient plant, and—what is of importance in comparison with battery work—simple and inexpensive switchboards. There is no trouble from general ground leak; and both arcs and incandescent lighting can be done from same leads. The only thing wanting is storage; and to what extent is that really necessary, and what does it cost? It is significant that throughout America, where direct current stations could have it for the asking, it is never used.

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* "Induction and other Things," ELECTRICAL REVIEW, October, 1889.

At present, however, we are using alternating currents in just about the worst way that could be possibly devised.

(To be continued.)

LONDON COUNTY COUNCIL.

AT the usual weekly meeting, the following report of the Highways Committee was submitted:—

Electric Lighting.—Precautions against Accidents.

We have to report that our attention has been drawn to an accident which happened on the 30th of November last to two gentlemen walking in Piccadilly, who received an electric shock by stepping on the cover of a street box belonging to the London Electric Supply Corporation, Limited. Although persons so injured may have a legal remedy against the company, we thought it our duty, as having a general supervision of the administration of the Electric Lighting Acts, to investigate the circumstances of the occurrence, and to communicate with the Board of Trade thereon. We have ascertained that the cover of the street box was flush with the pavement. It consisted of an iron frame filled up with cement. The conductors inside the box were all insulated with India-rubber, but one of them had been forced up so as to come into contact with the cover of the box at the point where a service line was jointed to it, and the insulation of this joint was so defective as to admit of a metallic contact being made. The Board of Trade expresses the opinion that efficient means should in future be taken to prevent any chance of contact between the conductors and the outer cover at the surface of the ground. We have accordingly resolved to recommend the adoption of special precautions in all cases where the approval of the council is required to notices for the laying of high tension mains. The Board of Trade also proposes to issue a general regulation placing upon the companies the duty of taking efficient means to render it impossible that the covers or other exposed parts of boxes or any adjacent material forming the surface of the street shall become electrically charged, whether by reason of leakage, defect, or otherwise.

Notices Under Electric Lighting Orders and Acts.

We have considered notices from the London Electric Supply Corporation as follows:—February 17th, 1891 (Registered No. 161), of intention to lay distributing mains in High Street, Deptford, New Cross Road, Broadway, and Lewisham High Road (1 plan); February 18th, 1891 (Registered No. 162), of intention to lay a distributing main along the south side of Great George Street, Westminster (1 plan). The proposed works are similar in character to those of this company approved by the council on previous notices; and we recommend that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 161 and 162), dated 17th and 18th February, 1891, respectively, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the under side of the paving, wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; and that, as an additional precaution against accident through defective insulation of the mains, the street boxes shall, in order to prevent the possibility of contact between any conductor and the cover on the surface, be provided with an inner as well as an outer cover, insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth.

Two further notices (Registered Nos. 162 and 163), have been given by the same company, dated 23rd and 25th February, 1891, respectively, of intention to lay service mains to No. 100, Victoria Street, No. 22, New Bond Street and No. 20, Berkeley square. These were given in accordance with the resolution of the council of 16th December last, to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid; and we report the receipt of them for the information of the council.

We have considered a notice (Registered No. 164), dated 20th February, 1891, with three plans, from the Metropolitan Electric Supply Company, of intention to lay mains in Kensal Road, Great Western Crescent and Road, Tavistock Terrace, Cornwall Road, Greenlane Bridge, Aldridge Road Villas, Leamington Road Villas, Ledbury Road, Westmoreland Road and Place, Shrewsbury Road, Westbourne Park Road and Crescent and Villas, Talbot Road, Richmond Road, Burlington Road, St. Stephen's Square and Road and Crescent, Kildare Terrace and Gardens, Alexander Street, Durham terrace, Sunderland Terrace, Westbourne Park, Pickering Place, Westbourne Terrace North, Desborough Terrace and Street, Hampden Street, Waverley Road and Terrace, Alfred Road, Brindley Street, Harrow Road, Woodchester Street, Cirencester Street, Senior Street, Philip Terrace, Emily Street, Stalham Street, Hasborough Street, Westbury Terrace and Road, Cumberland Place, Sutherland Place, Northumberland Place, Westbourne Grove North, Norfolk Road, Hereford Road and Hereford Road North, Monmouth Road and Monmouth Road North, Newton Road, Westbourne Grove Terrace, Westbourne Grove, Garway Road, Kensington Gardens Square, Leinster Square and Gardens, Princes Square, Moscow Road, Victoria Grove, Petersburg Place, Bark Place, Caroline Place, Uxbridge Road, Palace Gardens, Orme's Square, Queen's Road, Inverness Terrace, Queensborough Terrace, Porchester Terrace. The company has also submitted a tracing showing sections of the culvert which it proposes to use for the mains in the parish of Paddington, in order to meet the wishes of the vestry; and we see no objection to this. We recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 164), dated 20th February, 1891, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works in any of the thoroughfares referred to in the notice; that the mains be inclosed in 5-inch iron pipe and be laid under the footways wherever it is found practicable to do so; that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall, in order to prevent the possibility of contact between any conductor and the cover on the surface, be provided with an inner as well as an outer cover, insulated from each other as far as practicable; and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

The Kensington and Knightsbridge Electric Lighting Company has given notice (Registered No. 165), dated 23rd February, 1891, of proposed extensions of mains in Emperor's Gate and Grenville Place (1 plan). The proposed works appear to be unobjectionable; and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 165), dated 23rd February, 1891, of the Kensington and Knightsbridge Electric Lighting Company.

A notice (Registered No. 166), dated 25th February, 1891, with one plan, has been received from the Electricity Supply Corporation, of intention to lay mains from those already sanctioned in Charing Cross, into and along the Northumberland Avenue subway to the end of the Victoria Embankment for the purpose of affording a supply to the premises of the Society for Promoting Christian Knowledge, and to other premises in the avenue. The company also proposes to lay mains from the subway along Scotland Yard. The plan furnished by the company is not complete, and further details should be given. There appears to be no objection to the laying of the mains referred to. We are, however, of opinion that the company should be required to enter Scotland Yard from the nearest lateral passage in the subway; and we also think that the council's consent may extend to the laying of any service lines which may hereafter be found necessary for the supply of other premises. The plan submitted by the company is not complete, and the company should be asked to furnish a proper plan. We recommend (*a*) That the sanction of the council be given to the works referred to in the notice (Registered No. 166) of the Electricity Supply Corporation, dated 25th February, 1891, and to the laying from the mains of any service lines which may be hereafter found necessary upon condition that the company do furnish proper plans to the satisfaction of the council's chief engineer, and do give him two days' notice before the works are commenced; that the concrete floor of the road boxes in the thoroughfares, referred to in the notice, be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders in all the boxes be laid on 3-inch stone templates the full thickness of the brickwork; that the mains for Northumberland Avenue be placed in the subway here, and that those for Scotland Yard be carried through from the nearest lateral of that subway; that the positions to be occupied by the mains in the subway shall be subject to the approval of the chief engineer of the council; that the work of placing them shall be carried out, and that any damage that may be done to the subway in its execution, shall be made good to his satisfaction. (*b*) That the clerk be instructed to forward to the Electricity Supply Corporation a notice requiring it to place the mains for Northumberland Avenue, referred to in the notice dated 25th February, 1891 (Registered No. 166), in the subway of that thoroughfare.

EFFICIENCY OF TRANSFORMERS.

By WILLIAM STANLEY, JUN.

THE following data, taken from tests made at the Stanley Laboratory at Pittsfield, may be of interest to engineers. The transformers are presumably of the latest design, as they are entirely new, and obtained from the manufacturer within the last thirty days. The method adopted for obtaining the hysteresis and Foucault losses was the same as that given by Blakesley, known as Blakesley's split dynamometer method of determining lag, which, while it is not absolute and cannot be relied upon for very accurate measurements, is sufficiently proximate for commercial work and affords a reliable basis of comparison between the several transformers. It is unfortunate that two of the transformers were of larger size than the others, for it is comparatively easy to design a 1,200-watt transformer to have an efficiency of one per cent. greater than a 1,000-watt transformer designed with equal care would have. The weights of the active iron in the transformers tested varied 100 per cent. for a given output. It should be borne in mind that the column marked "maximum efficiency" represents in reality lower values than actually are obtained in practice, because the total loss in a transformer is not the sum of the loss by hysteresis and the C^2 R losses, measured when the performer is doing no work, but is less than the sum of these losses, because the hysteresis loss falls off as the load is increased upon the secondary, and generally that the figures are not intended for more than comparative results. All transformers tested converted from 1,000 to 50 volts. In all tested, save the Thomson-Houston transformer, the current was taken from one of the Westinghouse Company's alternators at a frequency of 138 periods per second. In the case of the Thomson-Houston transformer, it was tested with the current from a Thomson-Houston machine at 125 periods per second.

Column 1 gives the type and size of transformer; column 2, the current pasing through the transformer when the secondary was open; column 3, the potential on the primary; column 4, the $C^2 R$ loss in primary and secondary circuits; column 5, the percentage drop below normal potential on the secondary circuit at full load; column 6, the hysteresis and Foucault losses; column 7, the efficiencies at full load, estimated from columns 4 and 6 together. A schedule of the weights of the transformers is appended. It is important to notice that the watts lost per pound of iron in these transformers varies from 1·1 watts to ·3 watt per pound. As has been mentioned, the size of the transformer is an important item in estimating its efficiency. The transformer marked "Slattery," 25-light size (1,250 watts), attains a maximum efficiency of 94·0 per cent., principally because, being of 25 per cent. greater capacity, its copper and iron are more efficiently used. Certain transformers designed by the writer of 1,500-watt capacity exceed 96 per cent. efficiency estimated on this same basis as those in the table.

This fact, viz., that the efficiency of a transformer is a function of its capacity, clearly indicates that the transformers of large capacity should be in general use, as it is comparatively easy to design them of 5,000 to 10,000 watts capacity at an efficiency of 97½ per cent., while it is far more difficult to design a 250-watt transformer at an efficiency of 90 per cent.

Type.	Size.	Leakage current.	E.M.F.	Total $C^2 R$.	Drop.	Hys.	Max. eff.
Stanley... ...	20-light	·053 amp.	1,000 volts.	19·25	1·9	37·5	94·3
Westinghouse	20 „	·061 „	1,000 „	20·8	2·1	48·	93·1
Slattery ...	25 „	·056 „	1,000 „	30·2	2·	45·5	94·
National ...	20 „	·112 „	1,000 „	24·3	2·4	75·	90·1
T.-H.	25 „	·213 „	1,000 „	27·	1·8	129·3	87·5

Total weight ... Stanley ... (20-light) 46 pounds (without case.)
„ „ ... Slattery ... (25-light) 121 „
„ „ ... National ... (20-light) 81 „
„ „ ... T.-H.... ... (25-light) 145 „
„ „ ... Westinghouse (20-light) 85 „

Electrical World.

KENNEDY'S NEW ELECTRICAL DISTRIBUTION METHOD.

By RANKIN KENNEDY.

IN this new method of distribution the dynamo alternators generate two alternating currents in quadrature. Any alternator may be wound to generate two such currents without altering its design, in fact existing alternators may be altered to do so at small cost. The author found in experimenting that there is less fall in potential at the terminals, due to increase of current (in fact due to self-induction) when the machine was built with two armatures, one generating each current in quadrature.

Figs. 1, 2, 3 and 4, are diagrams of the dynamo alternator, fig. 2 is a section showing the path of the magnetic circuits, there are two armatures, one in each end of a cast iron hollow cylinder, C, these armatures are laminated and have flat coils laid on inside, the field magnet core rotates inside and has all its N-poles at one end, and all the S-poles at the other. Fig. 4 shows this field magnet core; it is of cast iron and carries the magnetising coil in the middle space, x. This idea of having all the N-poles on one side and all the S-poles on the other side of the field magnets of an alternator was introduced in 1886 by the author in alternators shown at Edinburgh Exhibition in that year.

Fig. 1 is a cross section showing by radiating lines, F, F, F, that although the wire coils are subjected to the full variations in magnetic flow, yet the cast iron case, C, carries a steady flow, the flow in passing accross the core spreads out so that when it reaches the cast iron it is uniform. Fig. 3 is an outline of the alternator, the rectifying commutators are fixed at R, on the shaft. These commutators shall be described later on.

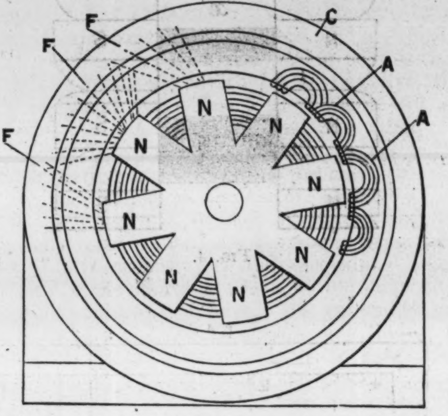


FIG. 1.

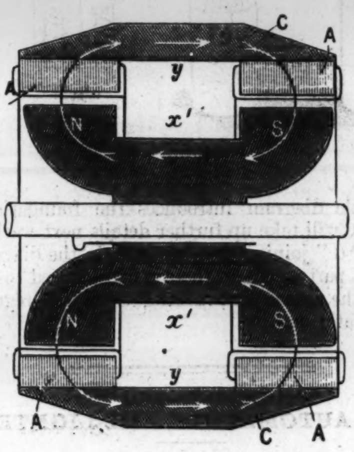


FIG. 2.

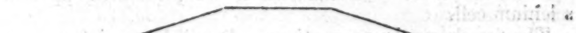


FIG. 3.

Fig. 5 shows, by means of two cells of a battery a diagram of the main distribution leads and their connection to the generators, at B is shown a secondary battery being charged. If the arrows are followed it will be seen that the current from the two generators are in series through the storage battery circuit while the currents act in parallel coils on magnet, M, and that by making the coils on magnet, M, equal in resistance, the current supplied by each cell will be equal. E^1 and E^2 are the leads from one generator, E^3, E^4, the leads from the other generator. It is obvious we could couple in a single wound magnet into the circuit between E^2 and E^3.

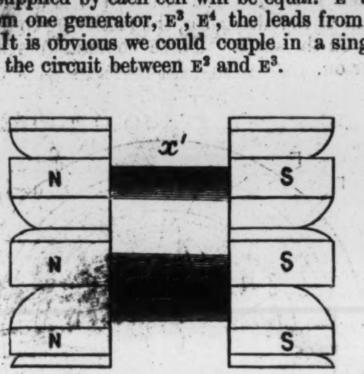


FIG. 4.

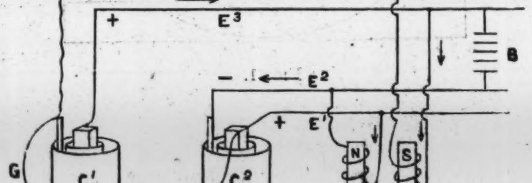


FIG. 5.

This simple diagram introduces the foundation of the method. We will take up further details next week.

The wire "G" joining the two cells in the diagram plays an important part in the method, it can be used to compound the field of the alternators, making them self-regulating as will be seen later on.

AN AUTOMATIC LAMP-LIGHTER.

IN a recent number of *Nature*, Mr. Shelford Bidwell gives some interesting particulars with reference to his pretty experiment of causing an incandescent lamp to be lighted up by the extinction or diminution of a light acting upon a selenium cell.

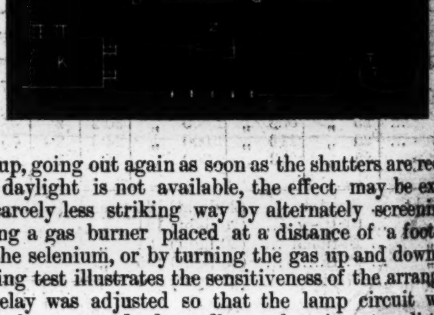
The fig. shows the connections. It will be seen that there are three circuits. The first includes a battery, A, of 24 small Leclanché cells, the selenium cell, H, and the magnet coils of the relay, R, and also a galvanometer, G. In the second circuit is a Leclanché cell, B, one pole of which is connected through the terminal, T, with the tongue of the relay, R, and the other through the magnet coils of the electro-magnetic switch, K, and the terminal, S, with one of the platinum stops of the relay. The third circuit contains the lamp battery, C, the incandescent lamp, L, and the tongue and stop of the electro-magnetic switch, K. The three simple switches, X, Y, Z, are useful for breaking any of the circuits.

The selenium cell, H, has a resistance in the dark of about 50,000 ohms, which is diminished to one-half, or less, by the action of diffused daylight, or by the light of an ordinary gas jet at a distance of 1 foot. The relay, R, is a "standard relay," as used in the Postal Telegraph service. Its tongue, connected with the terminal, T, oscillates between two adjustable stops, which are connected respectively with S and M. The electro-magnetic switch, K, is simply an ordinary electric bell relay; it is used in order to avoid passing a strong current through the delicate relay, R. The lamp, L, is an 8-volt lamp of 5 candle-power. The battery, C, consists of 5 bichromate or Grove cells.

The connections being made as above, the relay is adjusted so as to make the tongue press against the M stop, and then (the selenium cell being in the dark, or only feebly illuminated) it is adjusted until the tongue passes over to the S stop, which causes the lamp to be switched on. If now the selenium cell is exposed to a sufficiently strong light, the tongue moves back to the M stop, owing to the increased current through the magnet coils, and the lamp goes out. It is possible to adjust the relay so that the lamp is lighted automatically whenever the external illumination falls below any desired degree of intensity, and the adjustment when once properly effected, will remain perfect for days or weeks together.

The selenium cell is made by winding two fine copper wires, which serve as electrodes, very close together around a slip of mica, one surface of which is afterwards coated with a thin film of selenium. The cell used for the lamp experiment measures $2\frac{1}{4}$ inch by $\frac{3}{4}$ inch; the gauge of the copper wires is No. 36, and each wire makes 20 turns to the inch. The resistance of the cell in the dark is about 52,000 ohms.

The experiment may be shown by placing the cell near a window, and closing the shutters, when the lamp immediately lights up, going out again as soon as the shutters are reopened. When daylight is not available, the effect may be exhibited in a scarcely less striking way by alternately screening and exposing a gas burner placed at a distance of a foot or two from the selenium, or by turning the gas up and down. The following test illustrates the sensitiveness of the arrangement. The relay was adjusted so that the lamp circuit was just closed when a standard candle was burning at a distance of $7\frac{1}{2}$ inches from the selenium cell. The candle was moved slowly towards the cell, until the distance between them was reduced to $6\frac{1}{2}$ inches, when the increased illumination caused the lamp circuit to be broken. The candle was then moved back, and when the distance was once more $7\frac{1}{2}$ inches, the circuit was again closed. By moving the candle backwards and forwards over a range of about 1 inch, the circuit could be alternately closed and broken as often as desired. The extreme difference in the strength of the currents passing through the selenium under these changes of illumination was shown by the galvanometer to be rather less than 0·1 milliampère.



CORRESPONDENCE.

The three following communications arrived after our Correspondence pages proper were made up. To two of them we allude in "Notes."

Criticising the Critics.

May I venture to ask a small space to criticise the critic of my book? I am delighted at the criticism. It is a very creditable performance, and just what might be expected from the pen of the ultra orthodox. The only mistakes to be found are (1) in the method, and (2) in the matter. The former is a kind of shadowless echo from Mark Twain and Artemus Ward. The spirit undoubtedly was willing, but alas! the brain was weak. My preface seems to dominate all else in the critics mind; it is the Alpha and Omega of his criticism. May I parody an "Amurican" jingle for the benefit of your critic:

"The ELECTRICAL REVIEW was asked, Can you suggest a cure
For the debilitated state of certain lit'rachure?
'Ain't none—the author's ignorance is far too dark for lightnin';
While I who know enough to write hain't got no time for writin'."

I would also like to quote for his edification a sentence from Locke, for no doubt, as my critic makes so great a point of grammar, he must be well acquainted with the English classics at any rate—"He that will not eat till he has demonstration that it will nourish him; he that will not stir till he infallibly knows the business he goes about will succeed, will have little else to do but sit still and perish." It is amazing—to your critic; it is astounding, it is condemnable—still to your critic; that the author of a pettifogging little book should have the audacity to think for himself and say so many things that are unorthodox—and therefore wrong. It may be still more surprising to your critic to find that I, at any rate, look upon his criticism as the greatest compliment he could have paid me. Like Balaam he came forth to curse, but the curses are blessings in disguise. Let us see. The views expressed about induction are unorthodox. Has the critic shown they are false? My views as to the use of + and — differently in the external and in the internal parts of the circuit are unorthodox. Has my critic ventured to tackle me on this point? My views as to the constancy of action of a "line of force," and of the "pull of a magnet," are again altogether unorthodox, but my critic has not ventured to expose the idiocy of my views. So far as orthodox and heterodox views are concerned, the book professes to be heterodox, but the reviewer simply says it is *full* of mistakes and altogether wrong. Of course, from the orthodox view it is; it was intended to be. He fights shy of the heterodox problems, and shines in questions of grammar and lost letters in illustrations. One would naturally imagine that while filled with the divine afflatus—query, inflatus—he would have selected the most vital errors to damn the book. Yet what does he do? He gives three examples. One a stupid blunder, but clearly indicated by the context to be a blunder—where "10,000,000 heat units", is printed instead of "10,000,000 foot-pounds," and no engineering student would be misled for a moment. Another heavy charge is that certain letters are missing in a diagram. This is awful, because, of course, the whole thing is so exceedingly difficult that they must be known to make the reasoning clear. Unfortunately to support the reviewer's contention, the reader must be unable to say which is his right hand, for the book says N is the right-hand pole. With regard to the third grave charge, I am right, and your reviewer suffering from the hysterical condition consequent upon the nightmare of the preface which weighs so heavily upon him, cannot have weighed the evidence to the contrary of what he states. This champion printer's reader shows clearly that he looks, as he should in such character, for "literals," and misses the sense of what he reads. He has just said that at p. 78 *the text* is unintelligible without certain letters. It may surprise readers to learn that the figure he refers to is *not* mentioned on p. 78 at all, though the figure itself is placed there. The text is on p. 79. The error is not worth mentioning, except that those who grovel in the dust with a microscope should be quite sure they are right. To return to the charges. On p. 78, which he must have looked at, I find "the action in the conductive circuit is proportional to the number of loops or closed curves of lines of force," &c. On p. 79, I read "When the conductive circuit, R, is in a *vertical* position the maximum number," &c.; further down, on p. 79, "T is now at the bottom, B, and has now the maximum number of loops around it"; further on still, on p. 79 and turning over on to p. 80, "The number of loops increase till the circuit is vertical." Again, on p. 80, "the number of loops that pass around the conductive circuit, as this determines the electrical pressure and consequently the current." On pp. 81, 82, and 83, the same strain is continued; see, again, p. 106 (by the by, on p. 107, your critic will find the letters "ere" missing). I might also refer your critic to pp. 114, 115, 116, 117, 154, 155, &c. May I venture to quote again p. 155, "The numbers of lines looping the coil being fewest, practically none when the coil is *parallel* with the lines, and largest when at *right angles* to the lines." I could say much more, and, perhaps, to the point, but as I ask for criticism, not from a proof reader, however great an adept he may be, but from one who knows something of electrical engineering, I refrain from pursuing this point further.

Now, Sir, if your printer's reader wants to show more of his proficiency, please let him put a tag at the end of this after the following fashion. On p. 3 "symmetrical" is twice wrongly spelt; on p. 13 is an "o" wrong fount; in other places an "l" is missing, or an "i," or "nd," or "oil," and so on—dozens of errors; show that "I" is used instead of "me," "it" for "its," an adverb for an adjective, that a comma is misplaced, &c. This kind of thing will amuse him and won't hurt me. As yet he has shown a lion's heart combined with a baby's fist. If he really has got anything to say worth hearing, for heaven's sake let him take up my challenge on page 121 about the use of + and —. A discussion on this point will be such as all can understand. There are some other points I dispute your reviewer's ability to discuss, as he is evidently not fully acquainted with the subject. Still, if he desires it, I have no objection to hear him upon the "unit line of force," the variability or the non-variability of the action or actions of a line of force. The time for the hangman is not shown to have come by calling attention to missing letters and evident misprints. It is my intention to reprint all critical remarks with my comments thereon, as indicated in my preface. This will make a pamphlet equal to a shilling shocker.

C. H. W. Biggs.

Battery Transformers.

Your leader on "Battery Transformers" in the issue of the ELECTRICAL REVIEW of February 27th contains so many mis-statements, that I feel bound to call the attention of your readers more particularly to the points raised.

You speak of the futile attempt to carry out the lighting at Colchester by means of direct currents and secondary transformation.

It is common knowledge that the reason the lighting at Colchester was stopped, was the lack of support to a pioneer attempt, mainly in consequence of the loss of prestige due to reduction of capital, which prevented the demand for the current, and consequently the revenue from being of sufficient dimensions to warrant the necessary expenditure on standing charges.

Your article further states that the first failure was due to want of experience and the absence of perfection of various details.

The electric lighting at Colchester (considered by comparison with incandescent lighting generally at that period) was excellent. The light never once failed, and the lack of sufficient electromotive force occasionally on the mains was due more to the lack of proper financial support than to any other cause.

You state that "the inventors (*sic*) still clung fondly to their old plans."

I have yet to learn that persistence in pushing a good and successful idea is thus properly spoken of in the leader of a scientific journal, and I leave your readers to judge from such remarks of the probability of your leader writer holding a brief for some opposition scheme.

Your description of the direct current system as represented by the Chelsea Company, "Who would transform the current from 1,500 volts by means of secondary batteries and storing the whole amount" is so insufficient and deliberately misleading as to lend additional colour to the deduction which I make in answer to mis-statement No. 3. In my evidence at the Board of Trade enquiry, held at the Westminster Town Hall, I distinctly pointed out that the supply would be from storage, *only until the maximum demand rose to such an amount as would render the storage insufficient*, and that then continuous current transformers would be provided which would add to the capacity of the station some 50 per cent. and increase the general efficiency of the system while reducing the capital expenditure per lamp.

You state that the opinion of "experienced men in relation to automatic apparatus is that it is unwise to have anything to do with it."

Considering that some part of every electric system has of necessity to be automatic, it seems rather beside the mark for a technical journal to object to automaticity, especially when experience of actual working is in its favour.

You further state that "E.M.F. governors with fine shunt coils are unadvisable, as they are too liable to be broken by accident."

As a matter of fact, of the four E.M.F. governors in use at Chelsea, only one has ever required repair, the coils have never broken down, and the apparatus has always functioned properly.

I pass over your remarks, which "damn with faint praise" the whole of the apparatus which the writer of your leader evidently does not understand, his ignorance being quite evident when he states that "any hitch in the working of the E.M.F. governors would be attended with grave disaster."

This statement is utterly ridiculous and quite unfounded; the failure of any portion of the automatic apparatus would cause no "disaster," and such failure would not cause any interference with the supply to the consumer.

Your article also states that "charging accumulators in series has been generally fatal to the batteries."

Considering the fact that I am responsible for the manufacture of about 3,000 tons of lead secondary batteries, I take a little credit for knowing what is good and what is bad for a secondary battery, and I say that charging accumulators in series is the reverse of fatal; *it is in fact the best method of charging.*

You further state that "in charging three stations in series, all batteries are equally charged."

This is another instance of the utter ignorance of the system which the writer of your leader exhibits, and the continuation of your argument as to a heavy discharge in one district and a slight one in the others necessitating the engineer "pumping out" those more fully charged, is a sufficient corroboration of my remarks. When, however, you state that this was the one serious defect at Vienna, the explanation of the virulence of your attack on battery transformers is evident, and one obtains an indication as to the identity of your leader writer.

You state that charging at Vienna was performed in series and discharge taken off in parallel. Now, as at Vienna the charging in series proceeded while the discharge was also going on, it would be interesting to learn how "*discharge in parallel*" could possibly take place.

Your remarks as to the continuous current transformer suggest that a breakdown may be expected.

Major-General Webber's paper has scarcely done justice to this most useful class of machine, which has never given the least trouble, although it is constantly worked up to its maximum capacity, the insulation of this part of the arrangement is higher than that of any other part in the whole system.

I have no doubt that Major-General Webber will deal with your remarks about coal consumption, but your own contention merely indicates what I have so often endeavoured to show, viz., that although the storage and transformer system confessedly loses 28 to 30 per cent, yet they will have *a smaller coal and wages bill* than a system confessedly losing only 10 per cent. In the storage and transformer system, the whole work is performed under the very best conditions of economy, *i.e.*, always at full load; whereas on other systems for a considerable portion of the day the consumption of electricity is possibly not sufficient in itself to produce revenue sufficient to pay for the coals used during the slack hours.

I am not often led into noticing the adverse remarks of technical journals, preferring that my designs shall be judged by the ultimate result obtained in working, and I therefore read the virulence and evident animus of your leader as a compliment on the unlooked-for success of the Chelsea system.

Frank King.

March 4th, 1891.

Cantor Lecture.

In your last issue the secretary of the General Electric Power and Traction Company, Limited, at the request of his managing director, publishes a correspondence in which it is stated that the Tables 4 and 5 of Cantor Lecture, given by Mr. Kapp at the Society of Arts on Monday, the 16th ult., are entirely misleading, &c.

Now Table 4 shows the cost of the equipment of the Barking Road line with half-a-dozen 52-passenger accumulator tramcars carried out by the writer in the spring of 1889 for the Electric Traction Company, Limited, every item of which is accurate and their details can be furnished, the amount being £6,191 16s. (see ELECTRICAL REVIEW, February 20th). The cars proper are not included in the table, as only those items connected with the running expenses are dealt with, to include the cars would add £1,200 to the total, making it £7,391 16s., which is, perhaps, not what is desired.

Table 5 gives the running expenses for the full mileage of the line, *i.e.*, five cars in service, running a total of 100,844 miles per annum, being 8·068d. per car mile; this corresponds to the year ending June 30th, 1890; it is accurate, it must also be very nearly true, indeed, for the present time, since the most important items, namely batteries, wages at depôt, drivers, steam plant, remain unchanged, and these items represent 88 per cent. of the total. The life of the batteries is 10 months, or 300 discharges up to the present time. The cars have now been on the road 20 months and are working with their second renewals. It is to be hoped that the K-type plates may prove more durable. The end of the present year will show their merits or demerits as compared with the ordinary type. It is to be observed that the 8d. per car mile corresponds to the full mileage of 100,844 miles per annum, and that the wages at the depôt are a fixed charge, £677 6s. a year.

The mileage run during the first half year of 1890, under the charge of the writer was 44,047 car miles, the mileage run during the second half year (the installation now becoming the property of the General Electric Power and Traction Company, Limited), was 33,794 car miles, or a decrease in miles, run period for period, of 10,252. Is this a measure of the improvements? This low mileage runs up the proportion of shed wages from 1·612d. to 2·405d., making the car mile run 8·861d., which is unpleasantly near to 9d.

I must remind Mr. Mackenzie that I left the Electric Traction Company, Limited, at the time of its liquidation and was in no way connected with the Company to which he is secretary.

T. Frazer.

NOTES.

Electric Dials.—Mr. E. R. Hedgman, 23, Castle Street, Falcon Square, E.C., says that he supplies electric dials such as those enquired for by "L. B."

Electric Fire Alarms at Hove.—The justices of Hove have urged upon the Commissioners the desirability of providing electric fire alarms in that fashionable suburb of Brighton. The Commissioners, however, have passed a resolution that having satisfied themselves that there already exist means of telephonic communication at all times between different parts of the town and the fire brigades and police station, they are of opinion that it is unnecessary for the present to incur the expense of procuring fire alarms.

Electric Lighting in Manchester.—The Electric Lighting Committee of the Corporation are preparing an exhaustive report on the subject of electric light.

Electric Light in Leamington.—Major Majendie will, on Tuesday, the 10th inst., hold an inquiry at the Town Hall into the applications made to the Board of Trade by the Corporation and the Midland Electric Light and Power Company (Messrs. Arthur Chamberlain and Hookham) for orders to light the borough by means of electricity. The Corporation have given the company notice determining their contract and electric lighting of the Parade on the 25th inst., from which date the principal thoroughfare will be lighted with Bray's lamps. Special interest attaches to the forthcoming inquiry, which will be the first held at which a corporation and a company apply for rival orders while the latter is supplying the former.

Tramway Motors.—Some six years have elapsed since Mr. A. Reckenzaun pointed out, in a series of articles on "Electric Locomotion," which appeared in the Electrical Review that for traction purposes the ring armature presented considerable advantages, electrical and mechanical, over the drum armature in electric motors. We are pleased to see Mr. Reckenzaun's arguments confirmed by the recent action of the Thomson-Houston Electric Company. Professor Elihu Thomson has abandoned the hitherto extensively used drum armature in favour of the Gramme ring; a description of this modified motor appears in our American contemporaries, with the following comments: "The armature is of the Gramme ring type, which anyone, who has had a practical experience in electrical street car propulsion, will admit possesses many points of advantage over the drum type of armature. Any coil on the ring armature can be easily re-wound without disturbing its fellows. It is true that removable coils have been used on drum armatures, but not successfully, for it has been found after extensive and most thorough trial that while these coils are removable, they are practically not replaceable, and, therefore, that there is no particular advantage in their use." Mr. Reckenzaun went further than that, and showed that both mechanically and electrically, the wires crossing each other at the ends of the drum armature offer extremely weak points, and cause frequent breakdowns, which are avoided in the more compact Gramme ring.

Opening of the Mutual Telephone Exchange.—The first exchange of the Mutual Telephone Company, Limited, was opened in Manchester on Saturday morning, when 65 subscribers were put in communication. It was originally intended to begin with a much larger number, but the dense fogs of the last fortnight, by impeding operations, rendered it impossible to get a larger number ready for the opening. The wires of a great many more subscribers are partially finished, and additional names will be added to the list every day, until the whole of the 2,000 instruments which the Mutual Telephone Company have on order in Manchester have been connected. The transmitter used is of the magneto type, and will be so until the 30th July, when carbon ones will be employed. These transmitters have been specially manufactured by Siemens Brothers & Co., Limited.

Our Correspondence Columns.—The letters from Mr. King and Mr. Biggs have reached us only just in time for publication. Both will be answered *in extenso* in our next issue. We may add, however, for Mr. King's benefit, that his "identity of our leader writer is possibly a mistaken one, as the article emanated from this office, and was not inspired even by Mr. Crompton. Moreover, the "virulence and evident animus" exist only in Mr. King's imagination, for we have a great respect both for him and Major-General Webber.

Telephonic.—It is reported that the Mutual Telephone Company are shortly to open an exchange in Glasgow. The National Telephone Company are very busy at present in Glasgow, and other towns in Scotland, running wires for new subscribers.

Electric Launches on Windermere.—The four electric launches which during the Edinburgh Exhibition season of last year conveyed about 98,000 people along the canal between the city and the Exhibition, are shortly to be taken to Windermere, and will ply for hire on that lake.

Gazette Notices.—The contributories of the Regenerative Electric Light Company, Limited, will meet at 13, Victoria Street, on the 2nd of April, when the liquidator will lay an account before them showing how the winding up of the company has been conducted, and its property disposed of.

A general meeting of the members of the Northern District Telephone Company, Limited, will be held at No. 5, Moorgate Street, at three o'clock on the 6th of April for the same purpose.

The O. S. A. Smoking Concert.—The next concert will be held to-morrow evening at Mason's Hall Tavern, when a good programme is expected to be forthcoming. We hope that the students will muster in full force. It would be well however, if the worthy secretary took care to name the hour, 8 o'clock, at which the concerts take place, on the cards sent out.

St. James's and Pall Mall Electric Lighting Company.—This company put on seven new connections last week, including the Reform Club with 400 lamps. With the exception of the Athenæum and the Junior Carlton nearly all clubland in the district is served by the company, whose average additions to its already large output amount to about 350 lamps of 16-candle power per week, an increase which seems likely to continue.

A Proposed Reduction in Telegraph Charges.—At the annual meeting of the Association of Chambers of Commerce, held yesterday morning, a resolution was adopted to the effect that it was desirable that telegrams not exceeding twelve words should be forwarded by the Post Office at a charge of 6d., and the address free of cost, providing that it does not exceed six words.

The Lighting Bill of the House of Commons.—Whilst the lighting bill of the House of Commons is swollen this year by a sum of £1,300, being the cost of electricity in supplanting gas, the lamp account, which for years has stood at the enormous sum of £2,000 a year, is reduced by only £100. When the vote is reached in Committee of Supply Mr. Labouchere will call attention to this anomaly, and will move to reduce the vote for oil lamps by £1,000.

Nikola Tesla and English Electricians.—Profs. Crookes, Ayrton and others, Messrs. Swinburne, Ferranti, Mordey, &c., will find a perusal of Mr. Nikola Tesla's paper, on page 296, of interest. Some of the points contained therein will doubtless form themes for further discussion, especially those relating to Ferranti mains, open magnetic circuits, alternating currents and condensers.

Society of Arts.—On Wednesday next the following paper will be read: "Electricity in Relation to the Human Body." By H. Newman Lawrence and Arthur Harries, M.D. W. H. Preece, F.R.S., will preside.

Central London Railway.—This scheme is being considered at considerable length by a House of Commons Committee.

The Electric Light and Fires.—Messrs. Hampton and Sons have written the following letter to the *Standard*;—"It may be of general interest to know that the electric light has valuable properties other than giving the best artificial light, in being able to cause an immediate alarm in case of fire. An instance of this was seen on the occasion of the fire which occurred on our premises in Pall Mall East. In consequence of the fire having fused the wires, the light in the rooms of those in charge of the premises suddenly went out, thus causing an alarm to be given and the fire discovered almost immediately it broke out.

North East Coast Institution of Engineers and Shipbuilders.—The seventh general meeting of the session will be held in the Lecture Hall of the Literary and Philosophical Society, Newcastle-upon-Tyne, on Monday next, when Mr. William C. Mountain will read a paper on "Electrical Engineering, with Special Application to Electric Lighting."

Anglo-German Cables.—The Berlin correspondent of the *Standard* says it is likely that another cable will be laid between England and Germany.

Recent Interruptions and Repairs to Submarine Cables and Land Lines up to February 25th, 1891 :—

Submarine Cables.	Interrupted.	Repaired.
Jamaica—Santa Cruz	Dec. 15, 1890	Still interrupted.
Benguela—Mossamedes	Dec. 20, 1890	Jan. 27, 1891
Constantinople—Dardanelles ...	Dec. 31, 1890	Dec. 31, 1890.
" " ...	Feb. 16, 1891	Still interrupted.
Para—Maranham	Jan. 11, 1891	Jan. 20, 1891
" "	Feb. 10, 1891	Still interrupted
Cienfuegos—Santiago de Cuba ...	Jan. 13, 1891	Feb. 4, 1891
Buenaventura—Santa Elena ...	Jan. 25, 1891	Feb. 7, 1891
Odessa—Constantinople	Jan. 26, 1891	Jan. 26, 1891
Ceara—Maranham	Jan. 28, 1891	Jan. 31, 1891
Trinidad—Demerara	Feb. 11, 1891	Still interrupted.
Metelin—Aivali	Feb. 20, 1891	"
Land Lines.		
Transandine	Jan. 8, 1891	Still interrupted.
Cuban	Jan. 22, 1891	Jan. 29, 1891
Saigon—Bangkok	Jan. 28, 1891	Feb. 2, 1891
" "	Feb. 9, 1891	Feb. 12, 1891
" "	Feb. 19, 1891	Feb. 20, 1891
Moulmein—Bangkok	Feb. 19, 1891	Feb. 21, 1890

Cost of Electric Lighting in Paris.—The electric lighting of roads, squares, and promenades in Paris comprised, on the 31st December, 1890, 297 arc lights and 115 incandescence lamps. The official report gives the distribution and cost as follows :—

		Price of carcel hour. francs.
Place du Carrousel	16 arcs of 75 to 100 carcels...	0·00592 to 0·0044
Parc Monceau ...	12 Jablochkoff candles of 40 carcels	0·01184
Parc des Buttes-Chaumont ...	50 arcs of 80 candles ...	0·00375
	30 incandescence lamps of 1 carcel	0·025
Palais-Royal ...	85 incandescence lamps of 1·6 carcel	0·0166
Boulevards ...	47 arcs of 75 to 100 carcels ...	0·006 to 0·0045
	45 " " " " ...	0·0066 to 0·005
	39 lamps " " " ...	0·006 to 0·0045
Gare St. Lazare...	6 arcs of 150 carcels... ...	0·00466
Quai Jemmapes et Valmy... ...	66 arcs of 75 to 100 carcels...	0·00533 to 0·040
Avenue de Clichy	16 arcs of 75 to 100 carcels...	0·00533 to 0·004

Telegraphy and Revolution.—If we are to believe the *Petit Journal*, the insurrection at Oporto failed in consequence of certain injudicious telegrams sent by the chiefs of the movement to their accomplices. The telegrams, of which several were despatched, were worded, "The invalid cannot survive the night." The suspicions of the Government officials being aroused, none of the telegrams were delivered, and as a consequence a simultaneous revolt was averted.

The Duration of Telegraphic Currents.—A recent issue of the *Zeitschrift für Elektrotechnik* gives some interesting particulars on the duration of currents employed in telegraphic transmission. According to this journal the currents from a Morse instrument have a mean duration of 0·125 seconds ; with the Hughes from 0·04 to 0·05 seconds ; with the Meyer multiple 0·007 seconds ; with the Delany multiple 0·002 seconds ; and with the Wheatstone automatic 0·0018 seconds, at the rate of 600 words per minute, giving 33,600 currents per minute.

Electric Traction in Gera.—The Gera Street Railway Company, Limited, has been constituted with a capital of 1,800,000 marks (£90,000). The company, which has been financed by the Central German Credit Bank of Berlin, proposes to establish an electric railway both for passenger and goods traffic, and to supply current for lighting and power purposes.

Proposed High Level Electric Railway in Berlin.—Councillor von Siemens and other electrical engineers in Berlin have devised a scheme for the construction of an elevated electric railway in the south of that city. The proposed line would be so built as to form a connection with the town and circle railways, and would be a double line capable of future extension. The scheme will presently be discussed by the municipality and others interested.

An American Cable Manufactory in France.—We take the following from the *India-Rubber World* of New York : "The Standard Underground Cable Company, of Pittsburgh, is about to erect a factory in France, having received a large contract from the French Government for the supply of underground cables. The French Government objects to using anything not manufactured in France, and as an extensive system of underground wires has been determined on, the incentive for erecting a cable manufacturing plant on French soil is obvious. It is said that the proposed factory will be able to turn out about a million and a half dollars' worth of wires and cables a year. It is also said that the company is negotiating with a view to starting a cable factory in Germany. There is certainly a good field in that country, as underground wires are there rather the rule than the exception, and German cable manufacturers have grown rich by reason of the fondness of their Government for underground conductors. The underground telegraph system of the German Empire now contains nearly 4,000 miles of cable, and has cost over 20,000,000 dollars. As extensions are continually being made, there is a good prospect of the Standard Company getting plenty of work to do.

Institution of Electrical Engineers.—A general meeting of the students was held on Friday last, when Mr. Stanley Bone read a paper on "Electric Lighting Safety Apparatus," some specimens being shown by the General Electric Supply Company. At the next meeting, on March 13th, Mr. H. B. Little will read a paper on "Modern Telegraphy."

Personal.—Friends of Mr. W. T. Glover, of Manchester, will regret to learn that his recent bereavement has seriously affected his health, and his medical advisers have insisted on his entire cessation from business, and on a prolonged sojourn abroad, as necessary to his complete restoration to health.

Messrs. Crompton's Employes.—A smoking concert was given by the athletic club at the Chelmsford works last Saturday.

Ageing of Wine. — Mr. Otto Schulze, of the Alsace Electricity Works, has devised a new process for imparting age to wine. The novelty of this electrical process consists in the special apparatus employed, and of which further particulars will, says the *Elektrotechnische Zeitschrift*, be made public after further experiments have been conducted.

Babcock and Wilcox Boilers in France. — It is announced that the Babcock and Wilcox Company have authorised the well-known Creusot Works to manufacture their water-tube boilers, in order that the sale of boilers up to 10,000 H.P. may not be lost in France. This is due to the decision of the Paris Municipality that plant used in central electric light stations in France shall be made in that country.

Electrical Trades' Directory and Handbook for 1891.—The ninth yearly issue of this publication affords indisputable evidence of the very rapid advance of the electrical industries. The book has been brought up to date, the very numerous business alterations taking place all over the world in the first month of the new year being recorded. The increase in size is about 100 pages over the last edition, and 300 pages over the issue for 1889. Amongst the most useful features of the book may be mentioned a digest of the Law of Electric Lighting (specially written) ; a list of Central Stations in the United Kingdom for the Distribution of Electricity ; a list of Electrical Railways and Tramways ; a Summary of the leading Electrical Events of the past year ; Information relating to the obtaining Letters Patent ; a complete list of the Local Authorities of England ; and an enlarged Biographical Section, containing interesting sketches of the careers of the leading living electrical notabilities, with an excellent steel plate portrait of the president of the Institution of Electrical Engineers for frontispiece.

Telegraph Station Struck by Lightning.—*La Lumière Electrique* announces that the station at Kotonou, in the French Protectorate on the Gold Coast, has been damaged by lightning. It is stated that so long as the trees, which surrounded the building, remained standing no accident of this nature had ever occurred. It appears that the defence of Porto-Novo against the attacks of the King of Dahomey necessitated the cutting down of all trees; in the first thunderstorm which was then experienced, the station was struck by lightning. The extent of the damage is not reported.

Electric Lighting Installation at the Glasgow Athenæum.—Prof. Jamieson, consulting engineer for the Athenæum met the directors of the institution the other afternoon and explained to them the details of the electric lighting installation, which is now complete and in operation. It consists of two boilers of the dry-back marine type, made by Messrs. Lindsay, Burnett and Co., Moorepark Works, Govan. The boilers are each fitted with Murrie's low water alarms, and with Meldrum's patent steam forced draught, which, in conjunction with the new large iron chimney erected by Messrs. Braby & Co., produces an excellent draught of one inch of water pressure in the uptake and gives satisfactory results in the way of smoke consumption. The boilers are fed with water by means of Messrs. Carruthers and Company's patent two-cylinder direct acting feed pumps from a tank containing over 1,000 gallons supplied from two distinct street mains, so as to prevent as far as possible a breakdown due to either or both mains being cut off by the Water Trust. The feed water is heated by means of the exhaust steam. Steam is kept up to within 160 lbs. blowing off pressure, and 3,000 lb. weight of water can be evaporated per hour. In order to retain as much of the heat generated in the furnaces as possible, and to keep the engine and dynamo room cool, every part of the boiler, front, back, and sides, right up to the eyes, as well as the steam and exhaust pipes, have been covered with "Pearl Fossil Meal," and the flues with fire proof cement, to about 2 inches thick, by Messrs. Duff & Co., of Glasgow. This is a point of considerable importance, seeing that the dynamos are placed within 8 feet of the boilers, and the whole of the working machinery, including boilers, engines, and dynamos, switch board and storage cells are all located in one small room. There are likewise, in the same room, two triple expansion direct single acting engines made by Messrs. Alley & M'Lellan, each of which set of engines is coupled direct to and capable of working two Castle dynamos, made by Messrs. J. H. Holmes, Newcastle. There is thus provided an all-round duplicate plant. The speed of the engines and dynamos is maintained at 500 revolutions per minute, and registered continually by Schaffer and Budenberg's tachometers. Electrical energy is generated at a pressure of 115 volts, as indicated by Sir William Thomson's multicellular voltmeter. By an arrangement of switches and resistance coils one of each pair of the four dynamos may be used for charging storage cells at a pressure of 135 volts at the same speed. Messrs. Smythe and Payne's patent cutoffs are inserted in the main positive leads, and ordinary fuses in the negatives or returns. The whole of this machinery has been very compactly arranged into a very small space in the basement of the building, directly underneath the news room. Throughout the various departments there are about 400 16 candle-power incandescent lamps, ten of 300 candle-power and ten of 150 candle-power lamps of the Sunbeam type. Eight of the latter lights have been fitted up in the news room, and, altogether, the installation is one of the most perfect to be seen in the city of Glasgow. The boilers not only supply steam to the electric lighting engines, but also for the kitchen of the restaurant and the heating of the whole building, and steam is kept up at full pressure from 6.30 a.m. to 10.30 p.m. daily, except Sundays.

Spanish Electrical Journals.—*La Lumière Electrique*, in commenting upon the appearance of a new electro-technical journal in Spain, which is published under the title of *El Telegrafo*, remarks that only one other journal of the same nature is published in Spain—the *Telegrafista*, now in its third year of existence. Our contemporary has evidently overlooked the *Ciencia Electrica*, now in its second season.

New Submarine Boat.—The construction of the hull of the new submarine boat, the *Sirène*, is being actively pushed forward at the arsenal of Toulon. It is believed that with regard to the electric motor which will be employed for propulsion, the Marine Department will solicit, in the designing and construction, the opinion of electrical engineers.

Underground Conductors in Philadelphia.—The underground conductors of the Philadelphia telephone system have, for the last eighteen months, been placed in conduits of indurated and agglomerated wood fibre. It is said that this method of canalisation has given complete satisfaction. The material is prepared somewhat as follows: A fibrous wood is stripped of its bark, and then reduced to fibres of so great a length as possible; these are freed from all gums and juices, and are then moulded under hydraulic pressure. A secret chemical process is applied to render the fibre impervious to the action of destructive agents, gas, humidity, &c. The breaking strain of the material is stated to be 220 lbs. to the square centimetre; it withstands a temperature of 200°; and its density is about a fourth of that of iron. The conduits are made of all sizes, and the tubes are joined by means of rings easily removed.

Austrian Royal Train.—This train is being fitted up with a complete electric light installation, which will be finished in May. The plant is contained in one of the cars, and comprises a boiler and a 15 H.P. steam-engine, which is coupled direct to a dynamo. The number of lamps will be 120 of 16 C.P., and accumulators are being provided as reserve.

NEW COMPANIES REGISTERED.

Mobbs and Company, Limited.—Capital £13,000 in £10 shares. Objects:—To adopt an agreement between H. Mobbs of the one part and the company of the other part, for the acquisition of the business of ironfounder and engineer, now carried on at Northampton by Henry Mobbs. To carry on the businesses of civil, mechanical and electrical engineers and general iron and brass founders in all their branches. Signatories (with one share each): H. Mobbs, Fernside, Northampton; C. T. Mobbs, Fernside, Northampton; O. Mobbs, the Avenue, Northampton; F. J. Airs, 67, Victoria Road, Northampton; S. Kilby, 41, Swan Street, Northampton; Miss E. S. Mobbs, Cliftonville, Northampton; R. Walls, St. Giles's Square, Northampton. The number of directors to be not less than three nor more than seven, the first being H. Mobbs, C. T. Mobbs and O. Mobbs. H. Mobbs is entitled to remain a director for life, C. T. Mobbs and O. Mobbs may remain directors as long as they hold 450 shares. Qualification of ordinary directors, 20 shares. Remuneration to be decided at the general meeting. Registered on the 24th inst. by Messrs. Dunn and Duncan, 87, Chancery Lane, W.C.

Burgess and Company, Limited.—Capital £15,000 in £10 shares, to be issued as preference or ordinary shares, as the directors may determine. Objects: To acquire the business now carried on at Trowbridge, Wiltshire, under the style of Burgess & Co., and to carry on the business of manufacturers of, and dealers in electrical apparatus and appliances, also of china and glass dealers, iron and tinplate manufacturers, &c. Signatories (with one share each): F. W. Burgess, 23, Market place, Trowbridge; T. Hancock, 23, Market Place, Trowbridge; J. Hancock, 23, Market Place, Trowbridge; E. L. Shepherd, Abingdon, Berks; S. E. Hunt, Surbiton; J. H. Foley, Trowbridge; J. Clark, 62, Princes Street, Swindon. The number of directors to be not less than three nor more than seven, the first being, F. W. Burgess, E. L. Shepherd, J. Beaven, and J. S. Hancock. Qualification, 10 preference and 10 ordinary shares. Remuneration, £1 1s. and expenses for every board meeting attended, together with an increase when 10 per cent. dividend is paid. Registered on the 24th inst. Offices, 22 and 23, Market Place, Trowbridge, Wilts.

United States Power Syndicate, Limited.—Capital: £50,000, in £10 shares. Objects: To purchase the sole rights of manufacture and sale in the United States of

Priestman's and Hume's patents relating to hydro-carbon engines, and to carry on in the United States the business of makers and dealers in electric and motive power and lighting, mechanical engineers, &c. Signatories (with one share each): W. D. Priestman, Holderness Foundry, Hull; S. Priestman, Holderness Foundry, Hull; J. W. Barber, Sheffield; E. Priestman, Holderness Foundry, Hull; W. Y. Dent, Bellevue House, Woolwich; J. Priestman, 73A, Queen Victoria Street, E.C.; A. Priestman, Temple Buildings, Hull. The number of directors is not to be less than five nor more than seven, the first being J. W. Barber, H. Pawson, S. Priestman, J. Priestman, and A. Priestman. Qualification: £500. Remuneration: £100 per annum, each. Registered 26th ult., by Jordan and Sons, 130, Chancery Lane, W.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

W. T. Henley's Electric Light and Power Company, Limited.—The annual return made up to the 2nd January last, was filed on the 28th ult. The nominal capital is £100,000, in £1 shares. 6,918 shares are taken up, upon all of which the full amount has been called. The calls paid amount to 6,911, unpaid to *nil*, and the amount paid on 101 shares forfeited is £41 10s. 11d. Offices: 27, Martin's Lane, Cannon Street, E.C.

Electric Installation and Maintenance Company, Limited.—The annual return of this company, made up to the 23rd ult., was registered on the 27th ult. The nominal capital is £100,000, in £10 shares, 626 shares are taken up, upon 487 of which £5 per share has been called, and 139 shares are issued as fully paid. The calls paid amount to £2,260, and unpaid, to £175. Offices: 4, Great Winchester Street, E.C.

Wrexham and District Electric Supply Company, Limited.—The annual return of this company, made up to the 17th ult., was filed on the 25th ult. The nominal capital is £20,000, in £5 shares, 115 shares are taken up, upon all of which nothing has been called. Offices: Yspytty, 12, Queen Street, Wrexham.

CITY NOTES.

St. James's and Pall Mall Electric Lighting Company, Limited.

An extraordinary general meeting of shareholders of the above company was held on Monday last at Winchester House to consider two resolutions, one doubling the capital of the company by creating £100,000 of 7 per cent. preference shares, and another approving of alterations in the articles of association. The ordinary general meeting followed. The chairman of the company (Mr. E. Balfour) presided.

The Secretary having read the notice convening the extraordinary meeting,

The Chairman said that in proposing the first resolution—that the capital of the company be increased to £200,000 by the creation of 20,000 £5 shares, to be called preference shares, and entitled to a preferential dividend of 7 per cent.—he need scarcely dwell on the necessity of an increase in the capital, as the terms of the provisional order under which the St. James's Company existed obliged them to extend operations over the whole area of the parish of St. James. The questions which the directors had to consider were, firstly, the amount of increase, secondly, the form in which it should be made. To be able to state with any certainty the exact amount of money required, would need the gift of prophecy which the directors did not pretend to possesss, though as nearly as they could estimate, they considered the original capital ought to be doubled. There were three ways in which the capital might be raised; by creating ordinary shares; by creating preference shares bearing a lower rate of interest than 7 per cent., or by creating 7 per cent. preference shares. He would give the reasons which weighed with the directors in recommending the last of these three. They were aware that the founders' shares received half the profits after 7 per cent. had been paid on the ordinary shares. Thus, supposing ordinary shares were created, the present shareholders, instead of receiving half after 7 per cent. had been paid, would receive only a quarter. By the scheme proposed they would receive their complete moiety, and further, to place the present shareholders in a still better position, the directors had intimated that they intend, should the resolution be adopted, to offer 10,000 preference shares to the holders of ordinary stock, in proportion to the amount held. Here he would call attention to an error in Clause 14 of the report, in which the word *now* should have been written *then*, making it to read "it is the intention of the directors to offer 10,000 of such shares to shareholders then on the register," &c.

The resolution was seconded by Sir J. Morris.

A Shareholder asked if the preference was to be limited to 7 per cent., and if it was to have equal voting power with the ordinary shares

The Chairman answered "Yes" to both questions.

The question was asked if there was not likely to be a conflict of interests between the ordinary and the preference shares.

The Chairman thought any difference of interest would be very slight, and it was inseparable from preference shares in any company.

Mr. Muirhead wished to know if the board was unanimous in recommending the issuing of 7 per cent. preference shares.

The Chairman: That is a question which no shareholder has any right to ask.

Mr. Muirhead said he could not see the economy of raising money at 7 per cent. to pay off debentures which bore only 6. High interest generally meant bad security, but in this case the security was very good. The money could have been borrowed at 5 per cent. He himself had offered to take a large proportion of such an issue.

The Chairman replied that the money was not raised to pay off debentures. These were already paid off. Neither were they borrowing money, they were creating new capital. This gave them greater borrowing powers. If they issued debentures now they could only issue up to £50,000, the capital of the company being £100,000. If the money had been raised at 5 per cent. 1 per cent. would have gone into the pockets of the founders. They wished to benefit the ordinary shareholders, so issued the shares at 7 per cent.

Mr. Latimer Clark seconded the resolution, which was put and carried unanimously.

In proposing the second resolution altering the articles of association the Chairman said that the primary object was to get a quotation on the Stock Exchange, but the directors took the opportunity of remodelling the articles of association because they did not work so well as they might have done. It was also proposed to alter the annual remuneration of directors. Under the old articles they received 10 per cent. on the profits up to £1,500. It was intended now to strike out this maximum. The company had not been brought to its present state of prosperity without much anxiety and thought on the part of the directors, but in this matter they were entirely in the shareholders' hands.

In reply to a shareholder, the Solicitor to the company explained what the alterations in the articles of association were.

The resolution was put, and carried by seven to two.

The business of the ordinary meeting was then begun.

The Chairman said that in moving the adoption of the report there were a few matters of interest to them both in the past and present condition of the company. They would remember it was at one time the intention of directors to propose a scheme for the reconstruction of the company, but owing to the enormous improvement in their condition this was now become unnecessary. The original contract with Messrs. Clark, Muirhead & Co., had been practically completed, and as the result of placing their claim against them to a decision by arbitration, they had received an award of over £1,800. He wished to place the credit of this fact where it was due, namely, to Colonel Francis. At the same time arbitration seemed to him a risky, and possibly expensive resource, and he was still of opinion that to have agreed to a reasonable compromise would have been a better course to adopt. Owing to expressions of opinion at last year's general meeting, the directors offered £7,000 unissued debentures to shareholders. This was done against their better judgment, for they had considered it would be better if all these could be held in one hand. Experience had justified that view, for had this been done, the £7,000 of debentures would now be converted with the remainder. The directors hoped that the shareholders who held them would see a way of converting them into ordinary shares, and it was purely for this purpose that they wished to substitute the word *then* for *now* in the last clause of the report. With respect to the issue of shares in July last, the directors found themselves, owing to the want of support of shareholders, in the position of guaranteeing to subscribe £2,000 each. He mentioned this, because of the violent attack made upon them last year by a small body of shareholders. By the perusal of accounts it would be seen that the whole profits of last year was made in six months, and the greater part of it during the last quarter from October to December inclusive. Trade profits for the last six months represented for that period a dividend at the rate of 10 per cent. upon £100,000, which was an amount largely in excess of the capital at the disposal of the directors at any time during that period. He did not wish to prophecy, but believed he could put before them some figures which would satisfy them as to the prospects of the company. The output of current during the last two months was considerably in excess of half the output during the whole of last year. The number of lamps wired at the moment was seven times as large as in January, 1890, and they had applications from over ten times as many. The average daily revenue during the last week was not far from six times as much as during January, 1890, and this although the days were longer. If they would put these figures together, recollecting that the increase of bnsiness was upon their original capital, and with a small increase of staff, they would agree with him that they possessed a most valuable property, and one likely to be remunerative, and the directors felt that the results of the years' working had completely justified the course of the company's business as foreshadowed by them. The experience gained in the erection of the present station had placed them in a position of great comparative advantage in respect to the erection of the new works, both as regarded economy and efficiency. They would continue to follow the principle of subdivision of engine power, the adoption of which had been one cause of their success, and would still further develope that principle by developing a new station which could lend support to the other. He concluded by congratulating the shareholders on the able way in which the staff had rendered their services during the past year.

The resolution was seconded by MR. LATIMER CLARK, and carried unanimously.

The re-election of retiring directors and of auditors followed. The usual vote of thanks concluded the meeting.

Telegraph Construction and Maintenance Company, Limited.

THE twenty-seventh ordinary general meeting of the above company was held at its offices in Broad Street on Tuesday last, Sir George Elliot, Bart., in the chair.

The SECRETARY having read the notice convening the meeting, and the minutes of the two last previous ones, which were approved and signed,

The CHAIRMAN said that he had great pleasure in coming before them to make a very brief statement about the results of the working of the company during the last year. It had been a fairly successful one, and they had had a great deal of most interesting and useful work, and the more useful and interesting because it had been done so well. There had been an entire freedom from the slightest accident in the execution of those enormous works which had been performed during the year 1890. No misadventure had occurred when laying the deep-sea cables to impair the interest of their enterprise and to reduce the profits of the company. They would have seen in the report the work which had been done during the year past. They had laid 4,000 miles of submarine cable, and had manufactured a considerably larger quantity, as part of their contracts remained to be executed during the present year. This augured well for the future year. Indeed, their prospects were very encouraging; at the present moment a cable to be laid from Madras to Bengal was lying with others at their works. He hoped they continued satisfied with their 20 per cent. dividend, which the directors were able to give, and still leave something to fall back upon if a bad year came. The chairman then read the resolution that the report and accounts be received and adopted, that a dividend of 15s. per share be declared, making, with the amount already paid, a 20 per cent. dividend for the year, and that £61,524 11s. 11d. be carried forward to the next account.

A SHAREHOLDER complained of the large amount carried to reserve, £20,000 would have been sufficient.

The CHAIRMAN replied that the business was a very precarious one; they might have lost more than half that £60,000 by one accident alone. They were safer by having a good reserve.

The resolution was then put and carried unanimously. The re-election of retiring directors and of auditors followed. The usual vote of thanks concluded the meeting.

Keswick Electric Light Company, Limited.

THE adjourned annual general meeting of this company was held at the Court Buildings, Keswick, on Saturday afternoon, R. D. MARSHALL, Esq., J.P., Castlerigg Manor, chairman of the directors, presiding.

In moving the adoption of the report and statement of accounts, the CHAIRMAN said the business of the company was increasing, and to meet that increase they were obliged to extend the plant. The response to the appeal issued to the shareholders had only been partial, but he hoped they would think fit to put a little more money into the business to enable the directors to carry out the intended enlargement. The works had been dependent chiefly on water supply, which had been very precarious this winter, owing to the exceptional frost. Great difficulty was experienced in keeping the turbine clear and supplied with water. They had not met with the help they expected from the engine; but their engineer assured them they would be able to rely on it in the future. The directors were anxious to have the alteration carried out as soon as possible. He hoped the concern would go on prosperously. The balance of profit was small, but the concern was young and could not jump into profits at once. All new institutions had their ups and downs; yet, considering the difficulties with the water supply and the delay which occurred in some of the work, he thought the shareholders would be satisfied with the balance sheet. He hoped they would be able to show a better result next year.

Col. J. J. SPEDDING seconded the motion, which was carried unanimously.

Mr. W. WILSON remarked that from some conversation he had had with Mr. Thompson, he learned that the position of the company was better than was apparent from the balance sheet, as certain things had been paid for from revenue which might reasonably have been placed to capital.

Mr. THOMPSON said the matters were shown. There would have been a balance of about £50. The receipts altogether extended only over 11 months, and some only for 7, 8, or 9 months. He estimated that 12 months' takings would amount to about £460 as they were wired at present and as their arrangements were made.

Major CROSTHWAITE thought that there were many who would be willing to subscribe more capital. He was willing to increase his holding by another £100.

The SECRETARY (Mr. Joseph Broatch) said that there would only be £1,545 left to dispose of.

Col. SPEDDING recommended that efforts should be made to secure the necessary way leaves required for their cables, in order to supply the light to shareholders who wished to become customers.

A vote of thanks was passed to the Chairman for presiding.

London Electric Supply Corporation.

THE report for 1890 refers to the fire which occurred at the Grosvenor distributing station, and states that the directors are assured that with the measures now being taken for the equipment of the permanent distributing stations, any recurrence of such a calamity will be impossible in future. The premises damaged by the fire were insured, and are now being reconstructed in the most substantial manner. The interruption to business and the loss of income caused by the fire has been serious, and the directors regret that it will not be possible to declare any dividend upon the preference capital. The portion of the year during which supply was suspended is a period at which the revenue is, under ordinary circumstances, at its maximum, but owing to the severity of the winter revenue in excess of the ordinary rate would have been produced, which, had it been received, would have enabled the directors to pay a dividend on the preference capital. The results of working for the short period that ensued between the closing of the Grosvenor station and the cessation of supply on the 15th November, confirms the statement made in the last report, that the concentration of the whole of the generating machinery in one establishment, under the control of the chief engineer, would secure material advantages in supervision and economy. During the past year statutory powers have been acquired over several Metropolitan parishes, which have led to a more economical and beneficial disposition of the works. The board are making no applications for further powers this year, and will limit their Parliamentary business to defending themselves against opposing interests. Notwithstanding the loss of certain old customers after the fire, new applications for current are coming in from day to day, and large demands are arising in certain portions of the authorised area, in which, hitherto, there has practically been none. Works are now in hand with a view to meeting the material extension of the business which may be anticipated. Meanwhile, supply of current was resumed on the 15th February, and customers are being connected to the new underground mains as rapidly as possible.

National Telephone Company.—The directors of the National Telephone Company, Limited, announced last Saturday the issue of £350,000 4½ per cent. debenture stock, forming part of a total amount of new debenture stock which is limited to one-half of the subscribed share capital of the company for the time being, and redeemable at the option of the company on six months' notice at £110. The capital of the company is £4,000,000, of which £2,494,920 has been issued. Notice has been given to pay off the existing debenture stock and bonds. The new debenture stock will then be constituted a first charge on the entire undertaking and property of the company.

The Direct Spanish Telegraph Company, Limited.—The board have decided to recommend a dividend of 10 per cent. on the preference shares, and a dividend of 6 per cent. per annum together with a bonus of 1 per cent. on the ordinary shares, making with the previous half-year's dividend a total distribution of 7 per cent. for the year on the ordinary shares.

Anglo-American Telegraph Company.—This company has opened branch offices at Hay's Wharf, Tooley Street, London, and 46, Mark Lane, for the reception of telegrams to the United States of America, &c. Offices will also shortly be opened in Edinburgh, Leith, Dundee, Bradford, and Newcastle-on-Tyne.

The American Thomson Electric Welding Company.—This concern is preparing to launch a subsidiary company with a capital of £100,000. This will be the American Projectile Company, and will manufacture electrically welded shells out of seamless tubes and solid pointed ends.

Electric Construction Corporation.—Provisional certificates for the six per cent. first mortgage debentures are now ready at the offices of the corporation to be exchanged for bankers' receipts.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending February 20th, 1891, amounted to £6,114.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of February, were £3,406, as compared with £3,391 in the corresponding month of last year.

Direct Spanish Telegraph Company, Limited. The estimated traffic receipts for the month of February, 1891, are £1,953, as against £2,225 in the corresponding period of last year.

The Eastern Extension Telegraph Company, Limited.—The traffic receipts for the month af February amounted to £43,833, as against £38,466 in the corresponding period, showing an increase of £5,367.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of February were £59,155, as against £53,347 for the same period of 1890, or an increase of £5,808.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 27th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,895.

The West India and Panama Telegraph Company. The receipts for the half-month ended Februsry 28th, 1891, show a decrease of £625 as compared with the corresponding period.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (Feb. 26).	Closing Quotation. (March 4).	Business done during week ending March 4, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	99¾	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	47 — 48	47 — 48	48	47⅛
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84 — 85	84 — 85	85½	84½
2,809,310*l*	Do. do. Deferred	Stock	11½— 12	11½— 12	12	11⅝
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	11⅞	...
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2⅛— 2⅜	2⅛— 2⅜	2½	$2\frac{5}{16}$
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2 xd	1½— 2 xd	1⅞	1¾
50,000	City and South London Railway, Nos. 1 to 50,000	10	5½— 6½	6 — 7	6⅛	...
$7,216,000	Commercial Cable, Capital Stock	$100	107 —109	108 —110	110	108¾
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	$\frac{7}{16}$— $\frac{9}{16}$	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	11	...
6,000	Do. do. 10 p. c. Preference	10	16 — 17	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼	4⅛	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9½— 10½	9¾	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	$10\frac{5}{16}$	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14¼	14 — 14¼	14¼	14
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	109	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾— 15¼	14¾— 15¼	15	14¾
91,800*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	103 —106	103 —106	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	105½	104½
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	... ...	105 —108	106	105½
145,300*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	103 —106	103 —106	103½	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5½— 6½	5 — 6	6⅛	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2 — 2¼	1¾— 2	2	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3½	2¾— 3¼	3¼	2⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1¾	1¼— 1¾	1⅝	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9 — 9½	9 — 9½	9½	...
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 — 15¼	$15\frac{3}{16}$	$15\frac{1}{16}$
150,000	Great Northern Tel. Company of Copenhagen	10	16¾— 17¼	17 — 17½	17¼	17
15,000*l*	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	... ...	... ...	...	...
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	103 —106 xd	...	...
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	18½— 19½xd	19¼	18⅞
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —105	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	36 — 38	37 — 39	38½	37⅝
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9¼— 9¾	9 — 9½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	105—108 xd	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7¾— 8¼	8¾— 9¼	$9\frac{1}{16}$	$8\frac{1}{16}$
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4¾— 5	4⅝— 4⅞	$4\frac{13}{16}$	$4\frac{11}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¾— 13¼	12¾— 13¼	13	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10¼— 10¾	10¼— 10¾	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	¼— ⅜	¼— ⅜	...	...
9,000	Reuter's Limited	8	8½— 9	8½— 9	...	...
209,750	{ South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	..	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4½	...
37,350	Telegraph Construction and Maintenance, Limited	12	46 — 48	46 — 48	47⅞	46¾
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	97 —100 xd	101½	...
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	2¼	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	94 — 99	94 — 99	99	...
64,174	Western and Brazilian Telegraph, Limited	15	12 — 12½	12 — 12½	$12\frac{5}{16}$	12
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7¼	6¾— 7¼	6⅞	...
27,873	Do. do. do. 5 p. c. Deferred	7½	5 — 5½	5¼— 5¾	$5\frac{9}{16}$	5⅝
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2⅞— 3⅛	2⅞— 3⅛	$3\frac{1}{16}$	$2\frac{15}{16}$
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11½— 12	$11\frac{13}{16}$	11⅞
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	101 —105	100 —104 xd	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3¾— 4¼	3¾— 4	3⅞	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 30—32.—Elmore's Austrian Copper Depositing, 20s., 10s. Dis.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2—2¼.—Manchester Edison and Swan Company, £9 (£1 paid) 8s.—10s.—St. James's and Pall Mall Electric Light £5, 6½—6¾.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2—2½.—Preference, fully paid 4—4⅝.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1¼.

BANK RATE OF DISCOUNT.—3 per cent. (29th January, 1891).

THE ELECTRIC TRANSMISSION OF POWER.

BY GISBERT KAPP.

THE following tables to which we refer elsewhere were given at Mr. Kapp's second Cantor lecture before the Society of Arts:—

TABLE I.

$$\frac{\text{Volts} \ldots\ldots = \mathrm{H}\, v\, l\, 10^{-8}}{\text{Kilogrammes} = \mathrm{H}\, c\, l} \qquad 9{,}810{,}000$$

C Total current through armature; c, current through single armature conductor.
e_a E.M.F. in armature in volts.
τ Number of active conductors counted all round armature.
p Number of pairs of poles ($p = 1$ in a two-pole machine).
n Speed in revolutions per minute.
F Total induction in C.G.S lines.
Z " " English lines.

$$\text{Electromotive force} \left\{ \begin{array}{ll} \left. \begin{array}{l} e_a = \mathrm{F}\,\tau\,\dfrac{n}{60}\,10^{-8} \\ e_a = \mathrm{Z}\,\tau\,n\,10^{-6} \end{array} \right\} & \text{for two-pole machines.} \\ \left. \begin{array}{l} e_a = p\,\mathrm{F}\,\tau\,\dfrac{n}{60}\,10^{-8} \\ e_a = p\,\mathrm{Z}\,\tau\,n\,10^{-6} \end{array} \right\} & \text{for multipolar machines with series wound armature.} \end{array} \right.$$

$$\text{Torque} \ldots\ldots \left\{ \begin{array}{ll} \left. \begin{array}{l} \text{Kilogramme-metres} = 1{\cdot}615\,\mathrm{F}\,\tau\,\mathrm{C}\,10^{-10} \\ \text{Foot-pounds} \ldots\ldots = 7{\cdot}05\,\mathrm{Z}\,\tau\,\mathrm{C}\,10^{-6} \end{array} \right\} & \text{for two-pole machines} \\ \left. \begin{array}{l} \text{Kilogramme-metres} = 3{\cdot}23\,\mathrm{F}\,\tau\,c\,p\,10^{-10} \\ \text{Foot-pounds} \ldots\ldots = 14{\cdot}10\,\mathrm{Z}\,\tau\,c\,p\,10^{-6} \end{array} \right\} & \text{for multipolar machines.} \end{array} \right.$$

TABLE II.

TABLE OF WINDING FOR 8-POLE DRUM ARMATURE; 202 CONDUCTORS; SERIES WINDING; BRUSHES (±) 135° APART.

F	B	F	B	F	B	F	B	F
D	U	D	U	D	U	D	U	
202	25	50	75	100	125	50	175	
200	23	48	73	98	123	148	173	
198	21	46	71	96	121	146	171	
196	19 −	44	69	94	119	144	169	
194	17	42	67	92	117	142	167	
192	15	40	65	90	115	140	165	
190	13	38	63	88	113	138	163	
188	11	36	61	86	111	136	161	
186	9	34	59	84	109	134	159	
184	7	32	57	82	107	132	157	
182	5	30	55	80	105	130	155	
180	3	28	53	78	103	128	153	
178	1	26	51	76	101	126	151	
176	201	24	49	74	99	124	149	
174	199	22	47	72	97	122	147	
172	197	20	45	70	95 +	120	145	
170	195	18	43	68	93	118	143	
168	193	16	41	66	91	116	141	
166	191	14	39	64	89	114	139	
164	189	12	37	62	87	112	137	
162	187	10	35	60	85	110	135	
160	185	8	33	58	83	108	133	
158	183	6	31	56	81	106	131	
156	181	4	29	54	79	104	129	
154	179	2	27	52	77	102	127	
152	177	202						

TABLE III.

MOST ECONOMICAL CURRENT FOR ELECTRIC POWER TRANSMISSION.

D .... Distance in miles.
a .... Section of conductor in square inches.
E .... Terminal volts at generator.
e .... Terminal volts at motor.
HP_g .... Brake horse-power required to drive generator.
HP_m .... Brake horse-power obtained from motor.
c............... Current in ampères.
Efficiency of generator 90 per cent.; efficiency of motor 90 per cent.
g .... Cost in £ per electrical horse-power output of generator.
m .... Cost in £ per brake horse-power output of motor including regulating gear.
$\mathrm{G} = {\cdot}9g\,\mathrm{HP}g$ Cost in £ of generator.
$\mathrm{M} = m\,\mathrm{HP}_m$ Cost in £ of motor and regulating gear.
$t = 18{\cdot}2\,\mathrm{D}a$ Weight in tons of copper in line.
K .... Cost in £ per ton of copper, including labour in erection.
s............... Cost in £ of supports of line per mile run.
p............... Cost in £ of one annual brake horse-power absorbed by generator.
q............... Percentage for interest and depreciation on the whole plant.

$$\text{Capital outlay} = g\,\frac{\mathrm{E}c}{746} + m\,\mathrm{HP}_m + \mathrm{D}s + \frac{1{\cdot}6\,\mathrm{K}\,\mathrm{D}^2\,c^2}{\mathrm{E}c - 830\,\mathrm{HP}_m} = \mathrm{A}.$$

$$\text{Annual cost per brake horse-power delivered} = q\,\frac{\mathrm{A}}{\mathrm{HP}_m} + p\,\frac{\mathrm{HP}_g}{\mathrm{HP}_m}.$$

$$\text{Put } \mathrm{B} = \frac{\mathrm{E}\,p}{670} + q\,\frac{\mathrm{E}\,g}{746}.$$

$$j = \frac{830}{\mathrm{E}}\,\mathrm{HP}_m, \text{ the current which would be required if the line had no resistance,}$$

$$\text{and } \beta = j^2\,\frac{\mathrm{E\,B}}{1{\cdot}6\,q\,\mathrm{K}\,\mathrm{D}^2 + \mathrm{E\,B}}; \text{ then the most economical current at the given voltage E is}$$

$$c = j\left\{1 + \sqrt{1 - \frac{\beta}{j^2}}\right\}$$

$$c = j\left\{1 + \sqrt{\frac{1{\cdot}6\,q\,\mathrm{K}\,\mathrm{D}^2}{1{\cdot}6\,q\,\mathrm{K}\,\mathrm{D}^2 + \mathrm{B\,E}}}\right\}$$

For very long distances the term under the square root approaches unity and the most economical current the value $2j$; from which it follows that under no circumstances will it be economical to lose more than half the total power in the line.

TABLE IV.—COST OF TRANSMISSION OF POWER PLANT.

Distance in Miles.	H.P. Delivered.	Speed of Machines.	Cost in £.			Total Cost.* £	Cost per H.P. £
			Gen.	Mot.	Line.		
1·870	85	450	640	560	440	1,880	22·2
·280	195	500	760	680	132	1,800	9·7
·280	51	600	320	280	60	720	14·1
·375	90	550	520	480	80	1,240	13·8
·560	71	600	440	400	60	1,040	14·6
·280	40	700	260	240	20	640	16
·375	75	600	480	440	68	1,120	15
·500	87	500	520	480	100	1,260	14·5
1·560	150	600	760	720	330	2,050	13·7
·220	93	450	440	420	232	1,270	13·7
6·250	11	900	132	110	480	960	87
2·200	51	600	360	320	300	1,140	22·4
·187	60	900	240	220	18	600	10
5·000	41	750	240	200	344	1,020	24·8
3·750	220	600	1,040	960	640	2,960	13·5
·002	15	600	112	104	8	252	16·8
·250	19	700	160	160	20	390	20·5

* This includes regulating apparatus, instruments, posts, insulators, lightning arresters, erection, and supervision.

THE JUBILEE OF THE CHEMICAL SOCIETY

THE 50th anniversary of the foundation of the Chemical Society of London, was celebrated on February 24th. There was a general meeting of the Society in the afternoon at the rooms of the Society of Arts. This meeting was notable for the presence of two of the original Fellows, Sir Lyon Playfair and Sir William Grove. In the evening a soirée was held at the Goldsmith's Hall, where 50 years ago a few men interested in chemistry met together and decided to form themselves into a society for promoting the study of this science. An interesting collection of apparatus and specimens was on view. Amongst the exhibits were some relating to the progress of electricity. We will notice them chronologically.

A portrait-medallion of William Gilbert, M.D., author of *De Magnete*, founder of the science of electricity. Physician to Queen Elizabeth, born at Colchester 1540, died 1603. This medallion was executed in clay from the engraved portrait of Dr. Gilbert in the studios of the City and Guilds Technical College, Finsbury, by E. Dunkesley, student, and was electrotyped in copper in the electrical laboratory of the College, by E. Rousseau. Upon the surface of the copper medallion a layer of metallic cobalt was then deposited by the process invented by Prof. Silvanus P. Thompson.—Exhibited by Prof. Thompson.

Balance used by Henry Cavendish in his chemical and physical investigations.—Exhibited by the Council of the Royal Institution.

Galvanic battery used by Sir Humphrey Davy in the discovery of sodium and potassium.—Exhibited by the Council of the Royal Institution.

Eudiometer used by John Dalton in his researches.—Exhibited by the Council of the Literary and Philosophical Society of Manchester.

Bar of heavy glass made and used by Michael Faraday in the discovery of the rotation of the plane of polarisation in the magnetic field.—Exhibited by the Council of the Royal Institution.

Apparatus used by Sir B. C. Brodie, Bart., in researches on ozone, and the action of electricity, on gases, 1860-1872:—

a. Induction tube for producing ozone.

b. Gas-holder for preserving "Electrised gas" over concentrated sulphuric acid.

c. Measuring pipette, vol. 290-8 c.c. To deliver a constant volume of "Electrised gas."

d. Absorption bulb and aspirator for measuring residual gas after absorption of ozone (calibrated at each of the glass points).—Exhibited by Dr. W. Odling.

The original copper-zinc couple, the dry copper-zinc couple and its constituents, the original air battery and the early form of the air battery, invented and used by Dr. Gladstone and the late Mr. Tribe.

Samples of Penang caoutchouc obtained by precipitation by Dr. Gladstone and Mr. Hibbert.—Exhibited by Dr. Gladstone.

Apparatus used by Warren de la Rue:—

Specimen cells of the great battery of 15,000 cells used by Warren de la Rue and Müller in their researches on the electrical discharge in gases.

Spark micrometer for measuring the relation of potential and striking distance.

Tubes used in the study of the electrical discharge in rarefied media.

Voltameter used in connection with the great battery.—Exhibited by the Council of the Royal Society.

Eudiometer and calibration table with which ethyl was first analysed by Edward Frankland, D.C.L., L.L.D., F.R.S.

Eudiometer for the determination of nitrogen in nitrates and nitrites used by Dr. Frankland and Dr. Armstrong.

Guncotton slabs perforated by the electric discharge without ignition.—Exhibited by Sir F. A. Abel.

Original apparatus used by W. Crookes, F.R.S., in his investigation of molecular physics in high vacua, amongst which may be noticed:—

1. Apparatus to show the dark space round the negative pole. When the spark from an induction coil is passed through an ordinary vacuum tube, a dark space is seen round the negative pole. The shape and size of this dark space do not vary with the distance separating the poles; and only vary slightly with alteration of battery power, or with intensity of spark.

2. Apparatus to show the conveyance of the molecular stream to a focus.

3. Apparatus to show the green phosphorescent light of molecular impact.

4. Apparatus in which the negative pole is a coin; the device is reproduced on the glass by the phosphorescence excited by the molecular stream.

5. Apparatus to show that the line of phosphorescent light excited by a molecular stream in a plate covered with calcium sulphide is deflected by a magnet, thereby proving that the paths of the molecules are affected by the presence of a magnet.

6. Electrical radiometers.

7. A disc is supported by a carbon rod resting on carbon supports, which form a microphone. If a telephone be included in the circuit, the movement of the disc produced by the impact of a beam of light can be detected by the sound produced by the microphone.

8. Apparatus with idle poles to test the electrification of bodies interposed between the poles in the molecular stream.

9. Apparatus to test the effect of the electrification of a neighbouring conductor on the molecular stream.

Original apparatus used in the investigation of radiant matter, 1879:—

1. Vacuum tube with exploring pole, used in investigating the electrical condition of a highly exhausted tube when electrically excited.

2. Apparatus to show the action of the electrified walls of a vacuum tube on the stream of radiant matter projected from the negative pole.

3. Apparatus showing that the radiant molecules behave differently at a vacuum just short of non-conducting, to what they do in ordinary high vacuum.

Original apparatus used in showing that radiant matter is not radiant electrode matter:—

1. Apparatus showing that all the phenomena of radiant matter can be produced in tubes without inside electrodes.

2. Apparatus used in experimenting on the electrical resistance of high vacua.

3. Double vacuum tube of different electrical resistance.

4. Apparatus showing that the resistance of vacuum tubes is dependent on the material surrounding the poles.

Apparatus for showing phosphorescence in high vacua, 1879:—

1. Apparatus to show the phosphorogenic properties of the molecular stream, using the negative discharge.

2. Apparatus with cylindrical and corrugated electrode.

3. A large number of tubes containing diamonds, rubies and other crystals, which phosphoresce under the influence of the induction spark in vacua.

Researches on electric lighting by incandescence, 1881:—

1. Structureless cellulose for carbon filaments.

2. Incandescent electric lamp with structureless carbon filament.

3. The smallest electric lamp, diameter 3·8 mm., weight 1·9 grains 7·4 volts, 0·6 ampères, 1 C.P.

All the above exhibited by Mr. Crookes.

Original apparatus of Edward Daniell, F.R.S.:—

1. Cell of Daniell's original battery.

2. Daniell's constant battery (large cells).

3. Daniell's gas battery.

Exhibited by the Council of King's College, London.

PARLIAMENTARY NOTES.

THE TELEGRAPH IN THE ISLE OF SHEPPY.

Mr. KNATCHBULL HUGESSEN, on Friday last, asked the Postmaster general whether he would cause the electric telegraph to be extended from Sheerness to the point of Eastchurch, in the Isle of Sheppy, Kent.

Mr. RAIKES: In reply to the hon. member I am glad to say that I have arranged to have the telegraph extended to Eastchurch early in the next financial year, as those who have made application to me on the subject have been informed. The extension cannot be carried out during the current financial year, as the whole of the money voted for works of this kind has been expended.

POSTAL AND TELEGRAPH CLERKS.

Mr. J. ROWLANDS asked the Postmaster General whether the postal staffs of the offices in Edinburgh and Dublin were now on an equality as regarded pay, with the telegraphists of those offices where their official designation had been changed to that of sorting clerks, and whether he would state if similar alterations were to be made in London offices, and if so, when.

Mr. RAIKES: To the first and second questions of the hon. member the answer is in the affirmative. In reply to the third question I have to state that it is in contemplation to make similar alterations in London.

LONDON OVERHEAD WIRES BILL.

This Bill having been read a second time,

Sir R. LETHBRIDGE, moved "That it be an instruction to the committee to which the Bill is referred, to consider the advisability of amending the Bill, so that its provisions may be in accordance with Part II. of the Public Health Amendment Act, 1890." He said that as the Bill was admitted to be a compromise, the compromise would be more satisfactory, more complete, and more fair if the committee were to be instructed to assimilate the provisions of the Bill, as it affected the metropolis, to the provisions of the law as it affected the provinces generally. The Public Health Acts Amendment Act was passed after a good deal of careful consideration, and its provisions had been found to work satisfactorily in various large towns. He therefore thought it would be well if they were extended to London.

General GOLDSWORTHY said he had been one of those who had opposed the Bill of last year, but as now altered he had no objection to it. He did not think the instruction was necessary.

Sir J. GOLDSMID did not feel at all inclined to accept all the provisions of this Bill. It provided, for instance, that the County Council might charge a reasonable sum for the registration and supervision of all wires set up after the passing of the Act. This was adding insult to injury. The Company did not want to have their wires supervised, and it was not justifiable to charge them for such supervision. In all similar cases of public inspection in the public interest, the expense of such inspection was borne by the public. The County Council were also to have power to provide a number of bye-laws regulating the erection and maintenance of telephonic wires. Owing to pressure of private owners, the telephone companies were already considerably handicapped, and any further restrictions might seriously interfere with the development of telephonic communication in the metropolis, which was at the present time far behind the state of things in this respect in New York and other American cities.

Sir J. LUBBOCK said the clause in the Bill of last year was inserted in deference to the recommendation of a committee of this House. The charge for supervision of wires would not be made on the persons on whose premises the wires were affixed, but on the owners of the wires. He did not think the instruction was required, but the London County Council had no objection to it, as it would leave it quite open to the committee to consider the whole question.

Mr. H. FOWLER said he would be the last man to detract from the responsibility of the London County Council, but the general law of the land with regard to overhead wires was clearly laid down in the Act of the last session, which had been found to work well, and London ought to submit to the same law. An instruction to the Police and Sanitary Committee had been passed, that it should not have power to alter the general law of the land. Under these circumstances, he considered the present instruction inadequate, and would move as an amendment, words to make it mandatory on the committee to amend the Bill so as to bring it into accordance with the provisions of the Public Health Acts Amendments Act, 1890.

Mr. POWELL said that 180 towns had adopted the provisions of the Act of last year relating to overhead wires. The House, therefore, he thought, might view those provisions with confidence, and agree to the extension of their application to London. He supported the amendment of the right hon. gentleman opposite.

Mr. COURTNEY questioned the expediency of adopting the amendment of his right hon. friend, who wished to impose on the County Council the obligation of adopting *en bloc* the regulations respecting overhead wires which had been adopted in provincial towns. He thought it would be very unwise to prevent the committee upstairs from considering the advisability of variations in the code of regulations. He doubted whether the amendment of the right hon. member for Wolverhampton was in order, for it was usual to require notice of an amendment which was in the nature of an instruction. His right hon. friend had sprung this mandatory instruction upon the House. If it was to be seriously considered, it would be right to adjourn the debate. He suggested the withdrawal both of the original instruction and the amendment. The committee upstairs ought not to be fettered in their consideration of this subject, and the London County Council ought to be given the opportunity of showing to the committee, if it could, that the overhead wire regulations enforced in the provinces ought not to be made applicable, without variation, to the case of London.

Sir R. Lethbridge explained that he had proposed his instruction in a spirit of compromise. The amendment of the right hon. member for Wolverhampton he could not accept. After what had fallen from the Chairman of Committees, he offered to withdraw his instruction.

The Speaker said he doubted whether the amendment of the right hon member for Wolverhampton was in order.

Mr. H. Fowler said that, after the Speaker's intimation, he should not attempt to press his amendment. He should object to the withdrawal of the instruction moved by the hon. member opposite.

Sir J. Lubbock explained that the London County Council refrained from criticising the Bill of last year because London was excluded from its operation. In the circumstances, the County Council surely ought to be given the opportunity af appearing before the committee upstairs.

Sir R. Lethbridge asked leave to withdraw his instruction, but leave was not given.

The House divided, and the numbers were—

For Sir R. Lethbridge's instruction	99
Against	83
Majority	—16

Telegraph Messages for the Press and Private Messages.

Mr. J. Maclean asked the Postmaster-General whether his attention had been called to a statement in the *Journalist* newspaper, in which attention was called to the inconvenience of the present practice of the Postal Telegraph Department in using one system of counting messages for the press and another for private messages; for instance "thirty-four" was charged as one word, and "34" as two, although the transmission of the one word involved the use of 28 telegraphic signs, and of the two figures only 10 signs; "1890" was charged as four words, but "eighteen ninety" as two, although 27 telegraphic signs were required for the two words and only 20 for the figures; whether his attention had been called to the saving of official time which would result from an abolition of the higher charges for telegraphing figures as compared with words, and whether he would consider the advisability of doing away with a regulation of which press correspondents complained, and which caused some loss to the State.

Mr. Raikes: Before the introduction of the rate of a half-penny a word for ordinary telegrams, the regulations governing the charge for figures in those telegrams and in press telegrams were the same, every figure being counted and charged for as a separate word. At the same time all addresses were sent free. When the half-penny rate came into operation the addresses of ordinary telegrams were no longer sent free, and, chiefly as a concession to those who had to send telegrams to houses bearing numbers composed of several figures, it was decided to charge five figures as a single word. But in the case of press telegrams the addresses were still sent free, and as many as 75 words of text during the day and 100 words during the night could still be sent for 1s., whilst a copy of a telegram of the same number of words was telegraphed to any separate town for a charge of 2d. No change then, having here been made, there appeared to be no ground for a concession in the case of press telegrams, which were already the subject of such enormous privileges.

Kensington and Paddington Subway.

Mr. Baumann asked the First Commissioner of Works whether he was aware that certain persons, on behalf of the promoters of the Kensington and Paddington Subway Bill, had already begun to peg out portions of Kensington Gardens; whether that had been done with his authority; and whether, in view of the fact that the Bill had not yet passed either the Committee stage or the third reading in the House of Commons, he would order the promoters to suspend all further operations, and to cease interfering with the public enjoyment of the gardens.

Mr. Cobb further asked whether the right hon. gentleman was aware that the plans and sections showed that the proposed railway would cross Kensington Gardens in an open cutting, which would afterwards be covered over.

Mr. Plunkett: The Kensington and Paddington Subway Bill has passed a second reading in this House, and it will now be for a select committee to examine in detail the arguments for and against the measures. As to those general questions I do not desire to express any opinion one way or the other. I must be prepared to inform the committee, should it otherwise approve of the scheme, to what extent the construction of the line would involve any interference with the amenities of the park. With that view I called upon the promoters to indicate the line which they intended to take by the usual method of placing a few temporary pegs here and there in the ground. I may say that to their first proposal I objected, and I am now about to consider an alternative route. I do not believe that the placing of these pegs in the ground has in any degree interfered with the enjoyment of the gardens by the public. The case stands thus: The promoters must, if they can, satisfy the committee in order to get their Bill, and they must, I suppose, satisfy the public in order to get their money; and my hon. friend may rest assured that, until they have achieved these two purposes, they will not be allowed to begin operations in Kensington Gardens. I understand that, if all the objections were overcome, and the Bill were passed by the committee and afterwards by the House, the assent of the Crown would still be required. The course that it proposed to take is to construct the railway in sections, so that only a small part of the gardens at a time would be interefered with. Of course this is a question of a balance of conveniences for the public.

Sir H. Roscoe asked whether arrangements had been made for working the line by electricity or by cable, or whether it was merely intended to construct a subway for foot passengers as far the Albert Hall.

Mr. Plunkett: Objections were raised by the Science and Art Department to the proposal that it should be an electrical railway passing under their premises; and so the promoters have agreed to work by cable instead of by electricity. So far the difficulty has been overcome. The idea is that there should be a subway connecting Kensington Railway Station at South Kensington with the Kensington Gardens. Through the gardens the subway would consist of two tubes, and nothing of it would be visible. The most serious alteration that would be involved would be the destruction of a certain number of trees.

Sir H. Roscoe asked whether the right hon. gentleman had been informed that the running of cars in the subway would materially interfere with the scientific instruction given in the Normal School of Science and in the large school connected with the City of London Guilds Institute. Did he know that arrangements had been made by which the construction could be carried on without interfering with the work in the schools?

Mr. Plunkett: All these objections have been overcome by the promoters.

Mr. Picton asked whether the right hon. gentleman when he stated that the assent of the Crown would be necessary, meant anything more than the Royal assent which must be given to every Bill.

Mr. Plunkett: Yes, sir, Kensington Gardens are Crown property,

Telegraphic Communication at Sawtry.

In answer to Mr. Fellowes,

Mr. Raikes said: Since my hon. friend wrote to me in July last, my attention has not again been called to the question of the extension of the telegraphs to Sawtry. In answer to a question which he put to me in this house about 18 months ago, I explained that the main wires could not be made available for serving a telegraph office at Sawtry. I shall be very glad to have further inquiry made, but I fear that, unless the circumstances have altogether changed, it will only be possible to establish a telegraph office at Sawtry if the residents are prepared to enter into a guarantee. Perhaps I may take this opportunity of explaining to my hon. friend and the House that in cases of telegraphic extension the Postmaster-General has no option or alternative as to the course which he is bound by Treasury regulations to follow.

Mr. Fellowes asked whether the right hon. gentleman would bring before the Treasury the question of the great difficulty experienced in finding in poor country parishes a sufficient guarantee; and whether he would allow the receipts from telegrams coming in to go towards the guarantee fund, in the same way as the receipts from telegrams going out were allowed.

Mr. Raikes: I shall be very happy to make a representation to the Treasury; but I do not know with what success it will meet.

NEW PATENTS—1891.

2,798. "Improvements in solutions and salts for electro-deposition and other purposes." H. J. Altman. Dated February 16th.

2,834. "Automatically recording the value of shots upon target by electric apparatus." W. H. Elton. Dated February 17th.

2,840. "An improved method of heating curling tongs or irons by electricity." A. H. Watson and F. E. Antonini. Dated February 17th.

2,862. "Improvements in electric fire engines, also applicable to other electrically propelled vehicles." M. W. Dewey. Dated February 17th. (*Complete.*)

2,866. "Improvements in electrical measuring instruments." H. H. Lake. (Communicated by E. Weston, United States.) Dated February 17th. (*Complete.*)

2,876. "Improvements in the application of electricity to various useful purposes." E. R. Dale. Dated February 17th.

2,902. "An improvement in electric locomotives." G. S. Grimston and E. Wilson. Dated February 17th.

2,985. "Improvements in apparatus actuated by electricity for stirring, and turning over malt and grain." E. Edwards. (Communicated by J. Sandt and H. Sturm, Germany.) Dated February 18th. (*Complete.*)

2,999. "Improvements in electric arc lamps." H. H. Bigland and J. Burns. Dated February 19th.

3,003. "Improvement in element for electric battery." E. W. Mayer. Dated February 19th.

3,030. "Improvements in propelling vehicles by means of electric motors." M. R. Ward. Dated February 19th.

3,127. "Apparatus for automatically indicating loss or diminution of current in electric circuits." W. Cruyt. Dated February 20th.

3,198. "Improvements in galvanic batteries." F. Poudroux. Dated February 21st.

3,199. "An improvement in electrical switches." H. C. Harold and R. Jenkins. Dated February 21st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

6,156. "An improved electrical switch for the better and more safe means of breaking the continuity of an electrical circuit of high voltage, and again establishing the same." G. SCHULTZ. Dated April 23rd. 6d. Two contact pieces are secured to a base constructed of incombustible and insulating material; on this base is mounted a bridge piece supporting the working lever and cover of the switch. A wedge formed of copper is mounted on the long arm of the lever, but insulated from it. This wedge is forced by the lever between the contact pieces, the movement being assisted and secured by the action of a short spiral spring, placed in such a position as to act against three pivots, of which two are upon the lever. 1 claim.

8,892. "A new or improved method of insulating electrical conductors and conduits for the same." A. MUIRHEAD and C. R. A. WRIGHT. Dated June 9th. 6d. The inventors cut parchmentised paper or card into strips, and wrap these round the conductor longitudinally or spirally, and unite the edges or junctions of the paper with a suitable cementing material; or the strips may preferably be brushed over with, or soaked in, the cementing material before wrapping round. 4 claims.

10,076. "Improved safety connections or couplings for electric conductors." R. H. GOULD and T. GOTTSCHALK. Dated June 30th. 6d. Relates to a safety connection or coupling for electric conductors, the object of said invention being to entirely interrupt the electric current between two carriers, standards or posts by automatically interrupting or cutting out the connection between the said standards in case the wire should be broken or otherwise severed. The possibility of transmitting current by contact with the depending wire is entirely prevented by the ends of the wire being automatically released from their connections, so that the conductor is cut out for the entire distance between two carriers or standards. 4 claims.

10,868. "Improvements in electricity meters." E. DE PASS. (Communicated from abroad by E. Marès, of Paris.) Dated July 12th. 8d. Relates to a wattmeter of intermittent integration, and whose movable bobbin is suspended from a balance beam. 6 claims.

11,017. "Improvements in or relating to conduits and permanent way for electric railways, cable railways, or the like." W. P. THOMPSON. (A communication from abroad by J. Lynch, of America.) Dated July 15th. 8d. Has for its object the production of a drainage conduit composed of an electric non-conductor for effecting the drainage or removing of all water, dirt, trash, &c., which collect in an underground electric conductor chamber, and conveying the same at suitable points into manholes, and from thence to sewers through branch pipe connections. 5 claims.

11,699. "Process for obtaining chlorine and bromine by the aid of electricity." G. NAHNSEN. Dated July 26th. 4d. Claim:—The process for obtaining chlorine and bromine by the aid of electricity, consisting in considerably cooling the solutions of the halogen compounds and carrying out the electrolysis at a low temperature, substantially as described.

12,247. "Improvements in and relating to electric lamps or lighting apparatus." H. H. LAKE. (Communicated from abroad by G. C. Pyle, of America.) Dated August 5th. 8d. Consists in certain details of construction and arrangements of parts, whereby an even and regular feed of the carbons is maintained, whereby said carbons are firmly supported in proper relation, whereby an equal resistance is maintained in said carbons notwithstanding their varying lengths, and whereby the lamp is enabled to withstand sudden shocks without disarrangement of the mechanism of varying the intensity of the light. 10 claims.

12,566. "Improvements in electric arc lamps." E. C. RUSSELL. Dated August 11th. 8d. Consists in the combination of a vertically moving and intermittently rotating disc carbon and a pencil carbon, secured so as to stand vertically in the bottom of the lamp frame, and in the means for moving and controlling the disc carbon as described. 9 claims.

12,628. "Improvements relating to the welding of metals by electricity." H. E. FOWLER. Dated August 12th. 8d. Claims:—1. The method of welding metals by the aid of electricity which consists in holding the parts to be welded in contact, and causing an electric current to traverse the joint, then cutting off the electric current and applying external heat to complete the welding. 2. The method of welding metals by the aid of electricity which consists in holding the parts to be welded in contact, and causing an electric current to traverse the joint, then cutting off the electric current and applying external heat and pressure to complete the welding. 3. The method of welding metals by the aid of electricity, which consists in holding the parts to be welded in contact and causing an electric current to traverse the joint, then cutting off the electric current and applying external heat and pressure, and working the joint by rollers or hammers to complete the weld.

13,006. "Improvements in welding or otherwise working metals by electricity, and in apparatus therefor." H. H. LAKE. (Communicated from abroad by Prof. E. Thomson, of America.) Dated August 19th. 8d. Consists in passing through the metal a current of sufficient volume to soften or render the same plastic, and then swaging the metal into the form desired in a drop press. Consists further in applying pressure to the metal while heated to plasticity by the passage of an electric current, and then swaging the metal while still hot from the electric heating into the form desired by a swage applied in a line transverse to the said line of pressure. 5 claims.

CORRESPONDENCE.

Transformer Efficiency.

With reference to the discussion on this subject now proceeding at the Society of Electrical Engineers, allow me to point out that the efficiency of transformers can conveniently be tested with fair accuracy by any of the makers, if they will drive their alternator with a suitable continuous current motor and note the increase of current required when a bank of transformers is switched on. It is very probable this method has been employed, but if so, it would be well to publish the results, as many electricians have more faith in continuous current measurements than in any others that can be made. I have found the great difficulty in testing transformers is to make sure there is no abnormal heating caused by partial short circuits between the turns of wire due to moisture in the insulating varnish and cotton covering.

Leslie Miller.

February 27th, 1891.

Storms and Telegrams.

I feel that it is a sacrifice of dignity on my part, but as a final reply, I will shelve such rather than hurt by silence the poor feelings of one unknown.

Referring to the letter by Jno. McDonald in the REVIEW of 27th inst., I beg to say that, as he seems to know something about me and my career, and as I am totally ignorant of him, (his name, if it is real, is not in the books of the Institution of Electrical Engineers), if he will kindly publish his designation and address, I shall be happy to enlarge upon his letters in a proper manner, and thereby put him right, especially in regard to the employment of the A and single stay poles, and I will also give him the actual and indisputable number of such poles that gave way through insecure packing close to Inverness—nowhere else. Until he complies with this moderate request he will, I am afraid, be always in ignorance.

Arthur E. Gilbert.

February 28th, 1891.

P.S.—I think, Sirs, you should establish a rule to the effect that, *should any writer's name and address be desired, it shall be published in accordance with such desire, especially in matters pertaining to electricity, with a view of checking superfluous, and doubtful correspondence.* The rule, or principle, would be similar to that adopted in our Houses of Parliament, when a member's conduct becomes intolerable, and no real gentleman would, in my opinion, object to it.

A. E. G.

[This correspondence had better cease.—EDS. ELEC. REV.]

Kennedy's New Electrical Distribution Method.

Messrs. Mavor and Coulson's letter under above heading would have called for no comment from me had they not gone aside to make a statement regarding my method of distribution, which statement they do not attempt to support by any proof or argument whatever. They say that the system of Patten has the advantage over mine "*in simplicity, and that it certainly accomplishes all that my method proposes.*"

They have only read a very meagre account of Patten's and Kennedy's methods, and upon that slight acquaintance with them rush into print with such a positive comparison as above, a comparison I consider very unfair.

Whether Patten's or Kennedy's method, or neither, or both methods are to be the successful methods of the future, remains to be seen in the future; these are deep questions which cannot be settled in the flippant, off-hand, unsupported methods of Mavor and Coulson.

Patten's method and Kennedy's method are entirely different, although aiming at the same results. I sincerely hope Patten's method may succeed; there is plenty of room for us both.

I am thoroughly well acquainted with both methods, and during the continuation of the series of articles describing my own method, I am in the hope that I shall easily show that this new duplex pulsating system is by far the simplest method, and that it accomplishes much more than the proposals of any other inventor. If I don't do this, then it is open to anyone to expose my failure; but the exposition must be supported by rational proofs, not the mere opinions of a trading firm.

Radically, Patten's system and Kennedy's system differ. Patten takes one alternating current and splits it into its two component parts + and — waves; he sends all the positives into one circuit, all the — into another circuit; he then recombines them to form a true alternating current, or to form a unidirection pulsating current (which evidently must pulsate no less than 50 per cent. ±), and by combining the two separate circuits with a third alternating current, he proposes to charge accumulators.

In Kennedy's system *two* alternating currents in quadrature are simply rectified and combined in series for constant current, and also for constant magnetising either in series or parallel, and for alternating effects they are combined in parallel, magnetising oppositely.

Rankin Kennedy.

Glasgow, *February 28th*, 1891.

Cantor Lecture.

The Secretary of the General Electric Power and Traction Company, Limited, sent you for publication last week copies of two letters which passed between me and his company, but he omitted to send you a copy of a letter I had previously sent to the company. In justice to myself, I must ask you to also publish this letter :—

[COPY.]

Erba, Wimbledon, February 20th, 1891.

Messrs. The Electric Traction and Power Company, Limited,
Maldon Crescent, Prince of Wales Road, Kentish Town.

Dear Sirs,—I was surprised to hear last night from your Mr. Snell that he considers the figures I gave in my Cantor Lecture, with reference to the Barking Road Tramway, incorrect. When, towards the end of last year, I applied to Mr. Frazer for information about the working of battery cars, I was under the impression that this gentleman was the member of your company who had the entire control of your traction work, and I, therefore, took the figures which he gave me as authentic and correct. If, however, as Mr. Snell asserted last night, the figures are not correct, it appears desirable that the necessary corrections should be made in the tables I gave at the Society of Arts lecture, and I shall do this if you will kindly supply me with the exact figures.

Yours faithfully,
GISBERT KAPP.

Any of your readers seeing only the two letters you published last week would naturally come to the conclusion that the immediate cause of my withdrawing the disputed tables for correction was Mr. Mackenzie's letter, and that his hint about legal proceedings may have had something to do with it. This, however, is not so. I gave the figures under a misapprehension as to the exact relation between Mr. Frazer and the company, and as soon as I discovered that these figures were repudiated by the company I offered to correct them. To this letter the company made no reply, and also ignored it when sending some of the correspondence to you. I now ask you to publish it, in order to dispel the impression that I had to be asked to do what any fair-minded person would do on his own accord.

As to your remarks in your article on the "Cost of Electric Traction" about my tendering "a kind of apology," and not being able to "substantiate the pessimistic views," &c., I would remind you that I did not express any personal views, and indeed could not form any on the working of the Barking Road line.

A lecturer is expected to give his personal opinion on such things as mathematical theory or experimental facts which he can himself test; but when it comes to matters of administration, he can only give such figures as are given him, and he cannot undertake to vouch personally for the correctness of such figures. I gave in my first lecture the figures supplied by Mr. Frazer, because I was under the impression that at the time when these figures were compiled and given me, Mr. Frazer was at the head of the company's traction business; but as soon as I found that I was mistaken, I was equally ready to replace these figures by others supplied by the gentleman who has now charge of this concern, whoever that may be. In neither case can I personally vouch for the correctness of the figures, but must simply give them on the authority of my informant. The company tell me that Mr. Frazer's figures are wrong, and I therefore withdraw them; if the company give me their own correct figures, I shall insert them.

Gisbert Kapp.

A Silly Joke.

Some one has played a fine joke and taken sad liberties with the respected name of my friend Monsieur Wilfrid de Fonvielle, which appears as the signature of the extraordinary letter on page 287.

What wit, what cogency! Faraday, by using a horseshoe loadstone (in 1831), thereby anticipates the production of a horseshoe electro-magnet by Sturgeon in 1825. *C'est excellent—mais ce n'est pas sérieux.*

What a famous idea to refute my Cantor lectures! How admirable to produce *authentic documents* in the pages of *La Lumière Electrique* (where, by the way, nothing of the sort has appeared since the publication of my lectures) to upset my historical statement concerning Sturgeon! What a colossal success, that I in the face of "so formidable a document" should have "retreated somewhat!"

"Retreated" somewhat! Bless his honest heart, what does the man mean? I have not altered a line of the lecture about Sturgeon since it was printed; and that was a week before its delivery! *Vive la France!* He has retreated, *ce perfide Albion*, since the so formidable document was produced to him.

Didn't know about Ampère and Arago? Well, it is curious that I didn't, seeing that I expressly mentioned their work, and gave foot-note references to their original memoirs.

Now, really, don't you think that if the writer of that letter had been M. de Fonvielle, he would have known the difference between a horseshoe magnet of Siberian loadstone and an electro-magnet? But that is a mere detail; let it pass. And, lastly (which is the greatest joke of all), he would have known the difference between—well, you know who—and Mr. Cromwell Fleetwood Varley, F.R.S., the celebrated electrician, who died in 1883. The joke is that the writer of that letter *didn't know the difference!* Voilà!

Silvanus P. Thompson.

March 2nd, 1891.

[Prof. Thompson is quite at liberty to peruse M. de Fonvielle's original letter if he chooses to call upon us, but the greatest joke of all appears to us to be in the fact that our Parisian correspondent is likened to a Rip Van Winkle who has been sleeping for nearly 10 years, or is it that as S. A. Varley so often mentions his *late* brother Cromwell, M. de Fonvielle has learnt to believe in his resurrection ?—EDS. ELEC. REV].

The Letters of Sir William Thomson and Dr. Silvanus Thompson.—Quieta non Movere.

In reply to Sir William Thomson's letter, I would remark there are two sides to most questions. Could we have changed places, I think Sir William Thomson himself might have come to the same conclusion, as I *reluctantly* did, viz., that the reasons which stood in the way of complying with so reasonable a request as that of wishing to be supplied with a duplicate copy of the authorised standard were mainly diplomatic. I put it to Sir William Thomson, what would he have thought of me if, after promising to supply him with a few resistance coils I kept putting him off without vouchsafing reasons for doing so; and if, after months had elapsed, and Sir William Thomson in the mean time had been put to serious inconvenience, not to say loss, I then coolly told him that the matter had been placed in other hands.

I never had any intercourse other than official with the late Mr. Fleeming Jenkin; he was in my case simply the representative of the B.A. Unit Committee, and the facts are as I have stated. Happily for humanity, men's private lives often afford a strong contrast to that of their business lives. I take blame to myself for having mentioned Fleeming Jenkin by name, but I was betrayed into doing so by what

Dr. Silvanus Thompson had previously said. I must be allowed, also, to express my sincere regret that in the passage mildly commented upon by Sir William Thomson I was not more successful in combining the *suaviter in modo* with the *fortiter in re*.

Sir William Thomson took an active part in work of the committee; would it be too much to ask him to kindly inform me how it was that the official representative of the committee did not keep faith? When all is said and done, it was I, not Mr. Jenkin, who was the injured party, but Sir William passes this over in silence. I myself had every reason personally to regret that the B.A. Unit Committee was ever formed, but not so Prof. Fleeming Jenkin and other members of the committee who not only reaped honour and glory, but were rewarded in some cases for their labours; I think, with foreign decorations. In the case of Mr. Jenkin, I believe his connection with the committee was a stepping stone to a professorship.

It seems to have been quite forgotten that the late C. F. Varley was the first to inaugurate exact measurements in connection with telegraphy. In this, as well as in most of his other useful work, he received very considerable assistance from his brothers, and at the time the B.A. unit committee was formed (1862), the Varley unit introduced in 1854-1855 was in general use in this country and also in America, the sole manufacturers of resistance coils in the United Kingdom being the firm who were the manufacturing introducers of them, and of which, in 1862, I was the active partner.

So soon as the B.A. committee was formed, C. F. Varley assented to the abandonment of the Varley unit, and his doing so involved my firm in a considerable pecuniary loss, for not only were our standards at once rendered valueless, but the manufacture of resistance coils was stopped from the date of the formation of the committee (1862) until after the issue of the B.A. standards in 1864.

Now, seeing that the Varleys between them had created an altogether new industry, which was completely checked just at the time it was beginning to assume commercial importance, I think we had certain claims for consideration at the hands of the committee.

Before incurring the further expenditure which the change from the Varley to the B.A. unit necessarily involved, it was not unreasonable that I should want to make myself sure that the authorised copies of the standard issued were true to one another. As a practical man, I was not conscious of any difficulty in multiplying copies, and at the present time it seems quite inexplicable to me that there should have been any difficulty in the matter. There either was a difficulty or the committee, for reasons only known to themselves, did not consider it desirable to supply men like myself with more than one copy. Sir William Thomson could possibly throw light on this point.

Now, I maintain that the B.A. Unit Committee should not only have recommended manufacturers to supply themselves with more than one copy, but that they should have refused to supply single copies, on the ground that it was very desirable that the resistance coils made by all manufacturers should agree as closely as was practically attainable. Could I have obtained the six copies ordered, and which I was given to understand in the first instance would be supplied, we should have been able to have ascertained the percentage of difference between the copies, and from the average I should have obtained a more correct base to commence building upon, and not only could the firm have made sure that their own standards agreed with one another, but we could have then guaranteed that the resistance coils we manufactured were true to the authorised standard. This it was impossible to do because of the way the firm were treated by the B.A. Unit Committee through their official representative. Under the circumstances which have now been described, I would ask, Was it very surprising that I should in the end have arrived at the conclusion that, for reasons I will not attempt to specify, it was not thought advisable to afford me the opportunity of comparing the copies of the authorised standard issued, one with the other?

Exception has been taken by Dr. Silvanus Thompson to my having suggested that the official reports of the proceedings of the committee did not contain a detailed account of every hitch and every mistake made, and I am told that my conduct is "nothing short of infamous." Offence has also been taken because I have not apologised at command; as a matter of fact, in the letter so strongly animadverted upon by Dr. Thompson, I said that if Sir William Thomson, who was a member of the committee at its inception, should feel himself justified in making a certain plain statement, that I would then frankly acknowledge that I had been labouring under error, and would apologise for having made a misstatement. Well, Sir William has written, and his remarks are confined to an expression of the high esteem he had for his friend, the late Prof. Fleeming Jenkin.

I think I might be misunderstood did I not take some further notice of the scholarly contribution to polite literature which Dr. Silvanus Thompson has thought fit to favour us with; the letter of mine to which it professes to be a response, seems to have had a similar effect on the learned doctor, as a red rag sometimes, has upon an angry bull. Dr. Thompson's accomplishments and powers of verbal expression are known to be great, but I think he may be fairly congratulated on having surpassed all previous efforts in this, his latest literary composition.

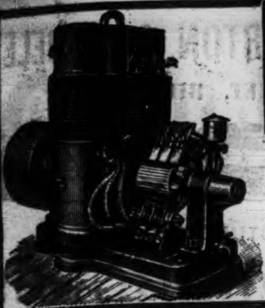
I am not wanting altogether in a sense of the ridiculous, and the communication I am now discussing is certainly unique. I note the heading, "Mr. Varley's blunder and his way out of it." I note, also, such sentences and words as "egregious blunder," discreditable and incredibly mean course," &c. "Characteristic deliverances of Mr. S. Alfred Varley—Joule is dead, Maxwell is dead, Jenkin is dead. These are the men over whom a Samuel Alfred Varley dares attribute his own incapacity of intellect. These are the men over whose supposed mistake he exultingly blew his own trumpet, &c. . . . Detected in this error. What does this person do? Apologise? No: that is not sufficient for one of such superior mental fibre." "It is nothing short of infamous," &c.

Might I suggest to one so gifted as Dr. Silvanus Thompson. To one so qualified to raise the tone of science, and that of the students who look up to him for guidance, that he might with advantage study the passage in the play scene of Hamlet—"I think the lady doth protest too much." Prof. Huxley has said that nothing is of more importance to the man of science than that he should appreciate the value of style, and a great master of style he tells us has put it on record that *le style est l'homme même.* All previous masters of style must now take a back seat. Dr. Silvanus has not been content to follow. He has soared higher. He has created a style. It is no small feat to have compressed within the space of less than half a column of letterpress a dictionary of expletives, and so varied, and at the same time so complete a collection of Thompsonian elegances as the learned doctor has done, and then the reading of it is so plain and clear, if it be studied in connection with my own article, "Posthumous Scientific Honours," and the letter of mine which appeared on February 20th; evidence was there adduced which went to show that on matters relating to scientific history, Dr. Silvanus Thompson was not always absolutely reliable. Attention was also called to the fact that in the earlier editions of "Dynamo Machinery," no mention whatever was made of my 1866 machine, the first self-exciting dynamo constructed; it was further pointed out that there was a maimed reference to my original dynamo in historical notes of the last edition of "Dynamo Machinery," where it has been so described by Dr. Silvanus Thompson as to convey the impression to those who read his book, that my 1866 machine was not a self-exciting dynamo. Now, if I may for once be guilty of plagiarism, and be permitted to borrow a few of the scholarly refinements which I quite recognise are the copyright property of Dr. Silvanus Thompson, then I might be disposed to say, "Detected and confronted by my plain statement of fact." What does the learned doctor do? "Apologise? No. He takes the discreditable and incredibly mean course" very commonly resorted to by a certain class of legal practitioners when they have cases to defend, which, they well know to be, absolutely unsound.

I do not know whether Dr. Silvanus Thompson has completely exhausted his evidently well-stocked repertory of classical elegancies, but I must be excused if I absolutely decline to take any notice of further contributions from his pen.

S. Alfred Varley.

February 28th, 1891.



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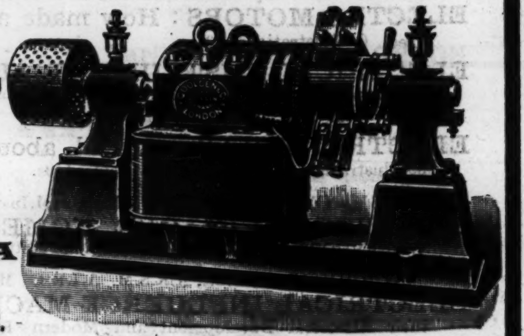

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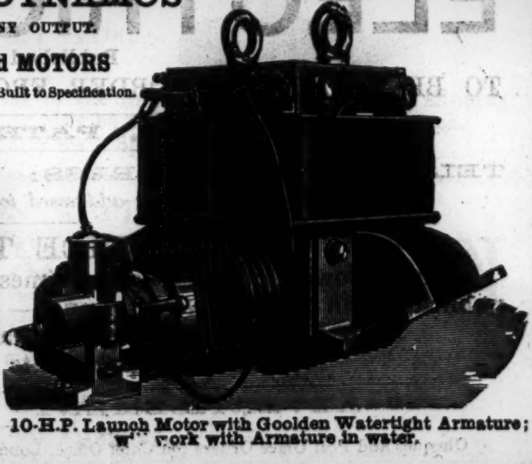

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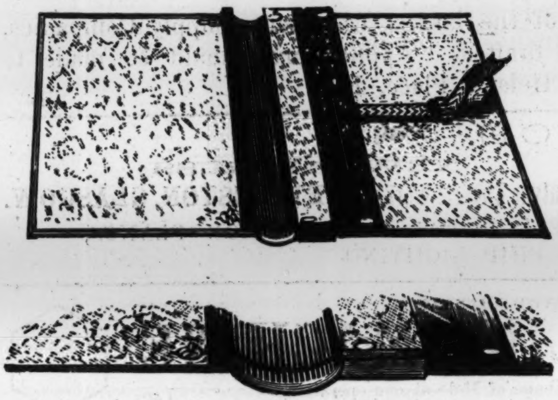

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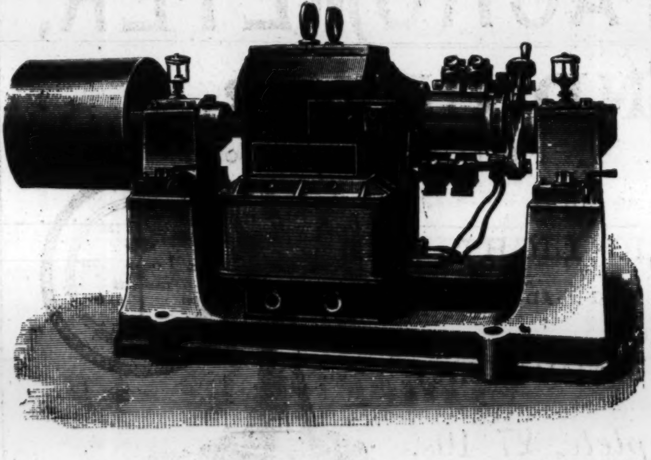

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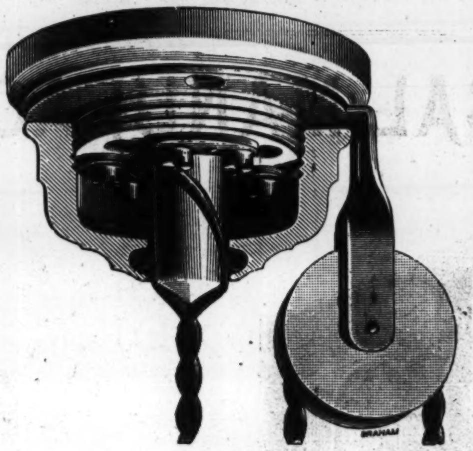

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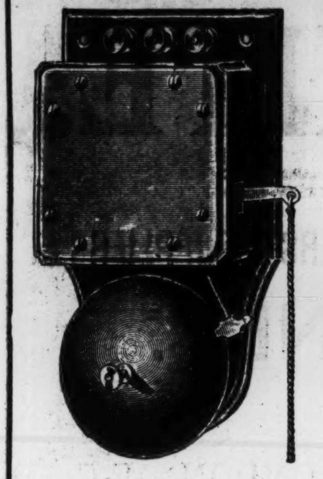

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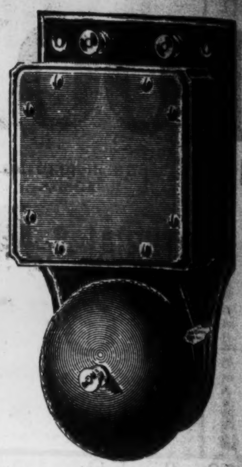

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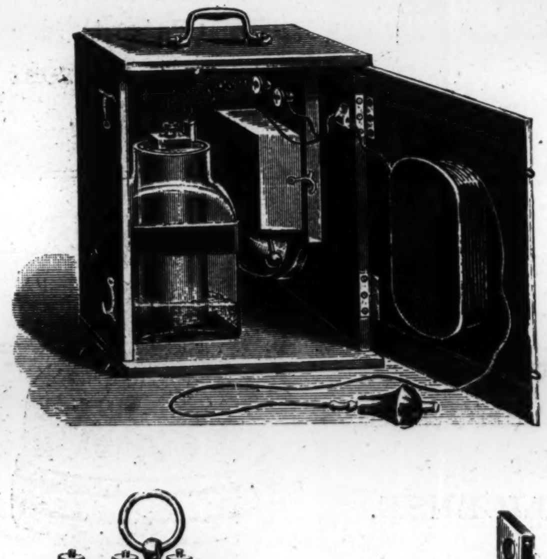

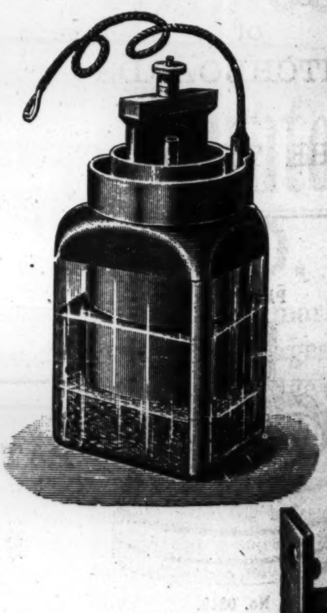

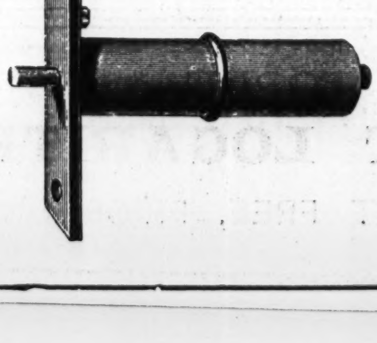

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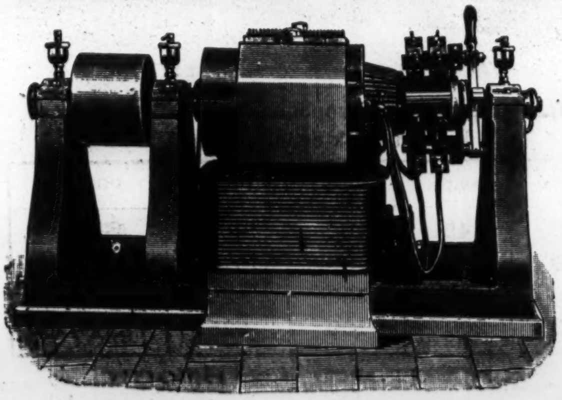

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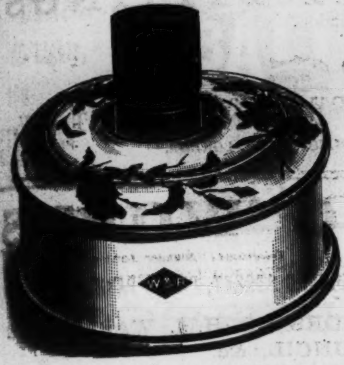

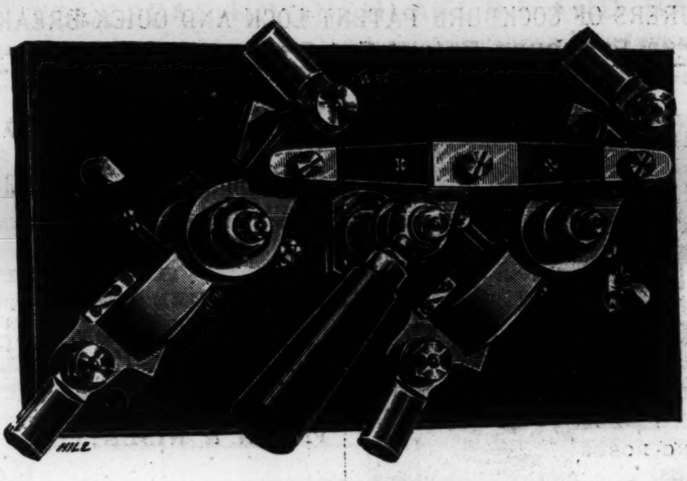

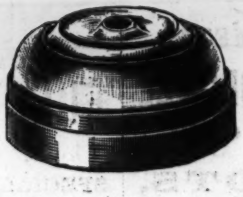

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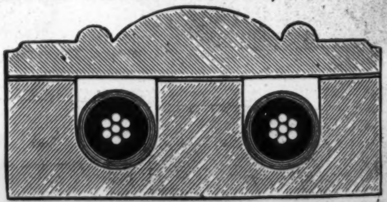

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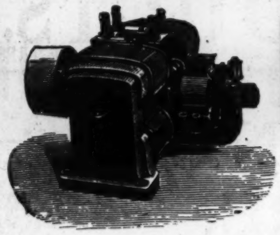

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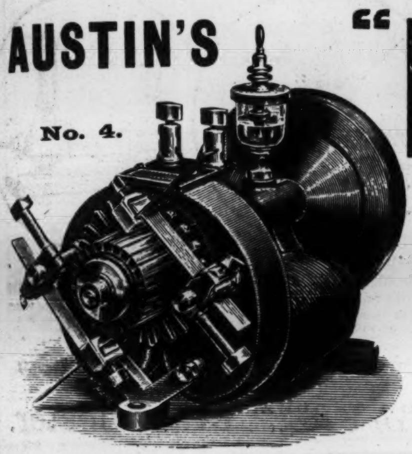

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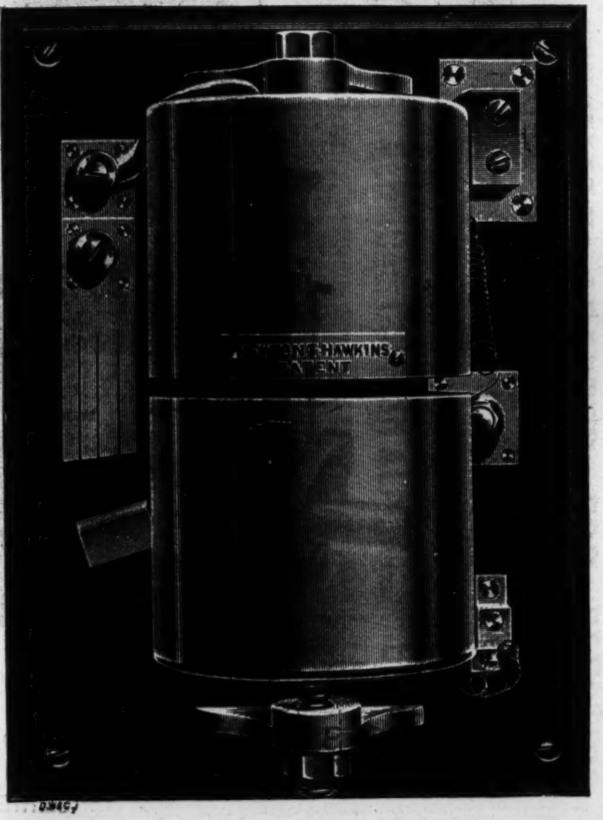

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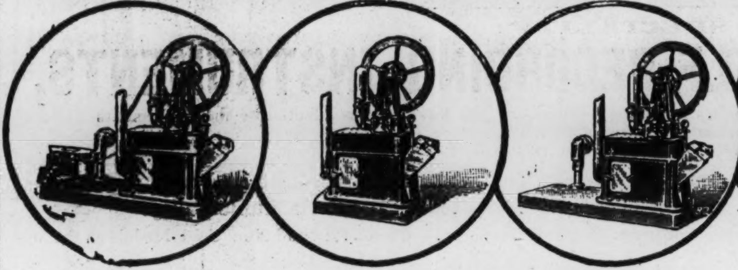

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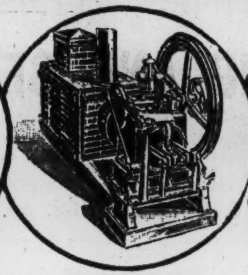

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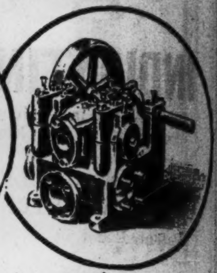

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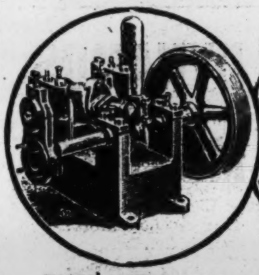

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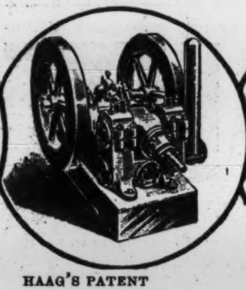

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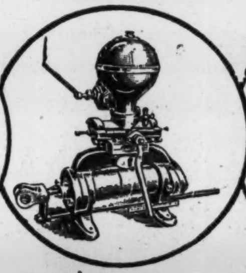

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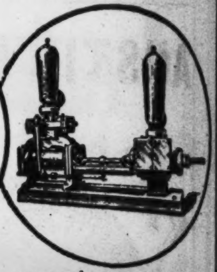

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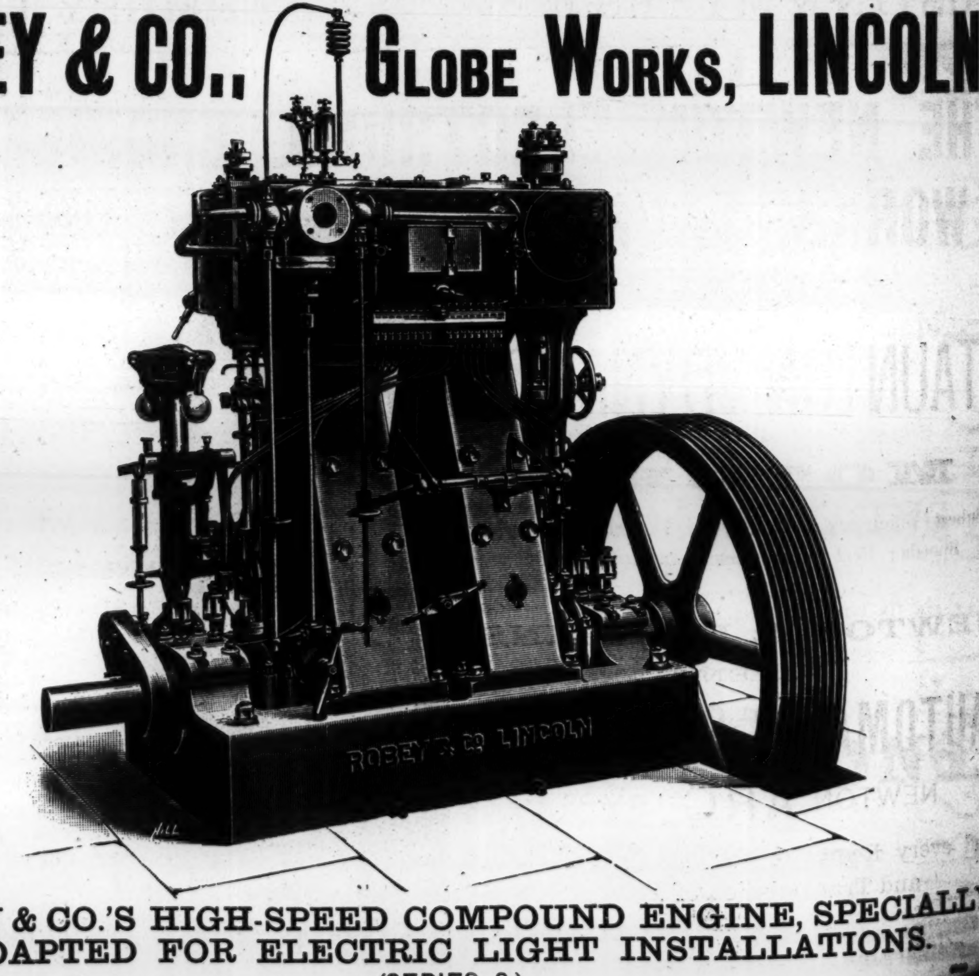

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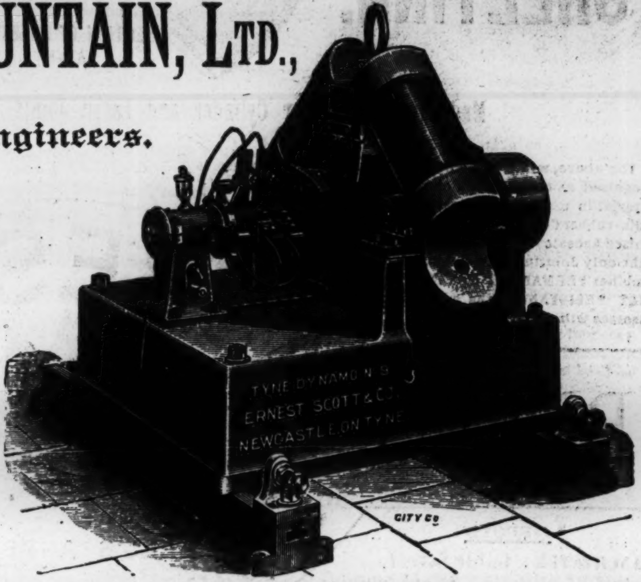

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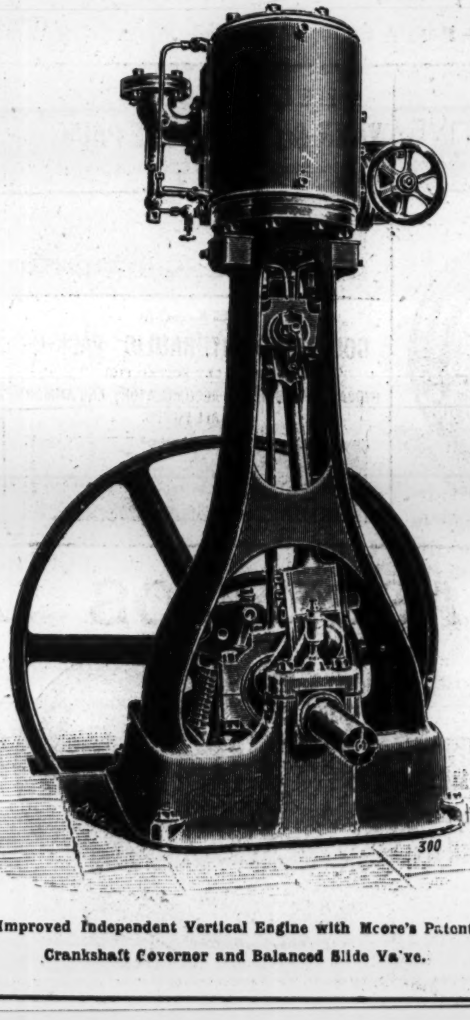

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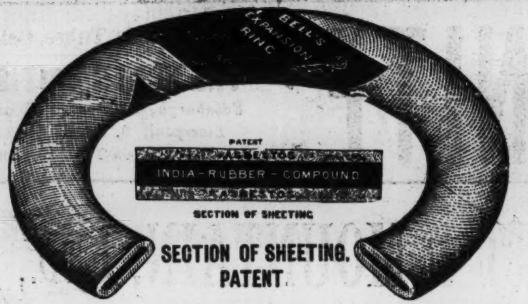

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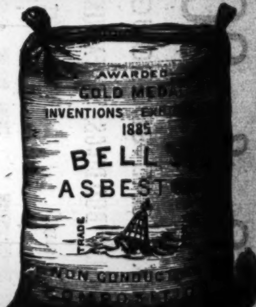

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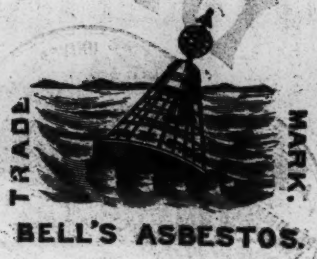

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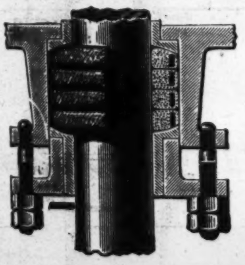

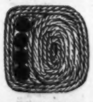

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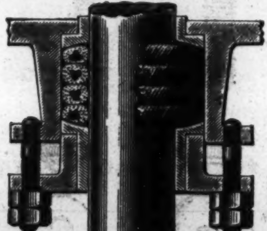

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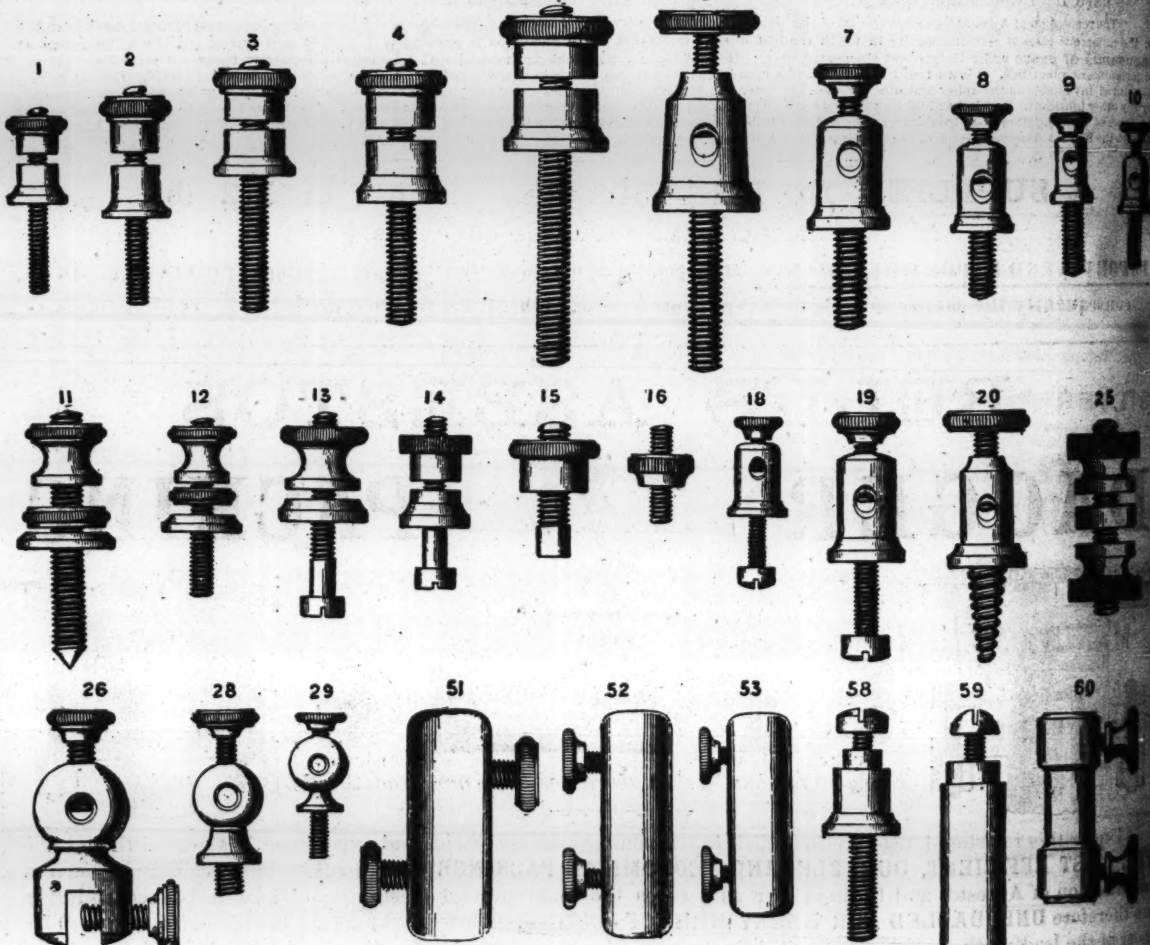

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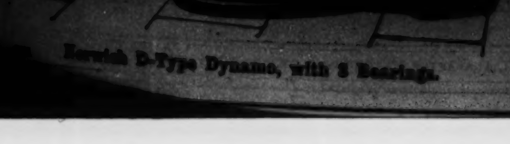

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